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[OFFICIAL NOTICE.]

Annual Meeting, Western Gas Association.

SECRETARY'S OFFICE, WESTERN GAS ASSOCIATION,
QUINCY, ILLS., April 29th, 1891.

The Fourteenth Annual Meeting of the Western Gas Association will be held at Louisville, Ky., on the 20th, 21st and 22d days of May. The Galt House will be the Association's headquarters, and the business sessions of the convention will also be conducted therein. Rooms should be secured in advance, as the indications all point to a largely attended meeting and an overcrowded hotel.

Papers on the following timely and important subjects will be submitted for the consideration of the members of the Association:

"Gas Engines; With some Practical Results and Comparisons," by E. H. Jenkins, Columbus, Ga.

"On the Removal of Ammonia from Illuminating Gas, and the Best Method for Its Accomplishment," by K. M. Mitchell, St. Joseph, Mo.

"On the Practical Efficiency of a Semi-Regenerative Furnace," by J. W. Dunbar, New Albany, Ind.

"Municipal Control as an Economic Factor," by Edward Lindsley, Cleveland, O.

"An Annex to a Small Gas Plant; What Should It Be?" by Wm. Tracy, Alton, Ill.

"On the Economic Results of an Electric Light Investment, Supplemented by the Author's Views of the Comparative Cost and Value of Coal Gas and Fuel Water Gas for Fuel Purposes," by Sylvester Watts, St. Louis, Mo.

"Does It Pay to Use Inclined Retorts in Small Gas Works?" by John Gimper, Leavenworth, Kas.

"An Experimental Illustration of a Simple and Accurate Method of Determining the Commercial Strength of Gas Liquors," by B. E. Chollar, St. Louis, Mo.

Next in value and interest to a paper itself is the discussion which it evokes. The Secretary will, therefore, take pleasure in mailing copies of any of the above essays to those of our members whose wish it is to look them over in advance of the meeting, that they may have ample time for a preparation of their opinion of the author's treatment of his subject. As a generous number of each paper will be printed, no one need fear that the supply will be exhausted, even though a general request be made for the same.

Application blanks and copies of the by-laws will be sent to those desiring to join the Association at the Louisville meeting.

A. W. LITTLETON, Sec'y.

[SPECIAL CIRCULAR.]

SECRETARY'S OFFICE, WESTERN GAS ASSOCIATION,
QUINCY, ILLS., April 29th, 1891.

To the Members of the Western Gas Association:

To remove any doubt that may exist on the part of our members as to the city in which the Fourteenth Annual Meeting of the Western Gas Association will be held, the Secretary takes this occasion of announcing that the original programme will be literally adhered to, and that Louisville will be the place. As it may be a surprise to some that a

change had been even contemplated, I would state in explanation that, since two or three conventions, in addition to the annual meeting of our Association, will be held in Louisville during the same week in May, grave doubts arose as to the ability of the Louisville hotels to properly house our members. As the case was urgent and the time allowance short, President Egner sent telegrams to the various members of our Board of Directors explaining the situation and asking their opinion of the advisability of a change. All agreed that suitable hotel accommodations were indispensable to the comfort of our members and the success of the meeting, and that if proper quarters could not be obtained in Louisville there was no alternative but to issue a call for a meeting to be held in some place other than Louisville. Nearly all of the members of the Board added, however, that if reasonably good accommodations in the Falls City could be assured, they would strongly recommend that no change be made. In the meantime, President Egner had set the wires at work and kept them so successfully employed that his negotiations ended with the most positive assurances, from the well and favorably known house of Dennis Long & Company, that our members need not have any misgivings on the subject whatsoever, and that ample hotel accommodations for all will be provided. Mr. A. H. Barret, Chairman of our Committee of Arrangements, writes in the same strain. As the promise of the gentlemen in question is equivalent to a guarantee of a performance, the Secretary feels that he risks nothing in saying that first-class hotel accommodations can be readily obtained by those who attend. I trust, therefore, this statement will be sufficient to assure all who are interested in the matter that whatever rumors may be in circulation to the contrary, the 20th, 21st and 22d days of May, 1891, will witness the best and most largely attended of all the meetings of the Western Gas Association, and that to the hospitable city of Louisville will fall the honor of being the place in which the same will be held.

Very respectfully, A. W. Littleton, Sec'y.

BRIEFLY TOLD.

Mr. McMillin's Condition.—The many friends of Mr. Emerson McMillin will, no doubt, rejoice at having positive assurance that the injuries received by him through the overturning of a Wagner sleeping coach (attached to Big Four Train No. 10, east bound from St. Louis), at an early hour of the morning of Sunday, April 26, are not nearly so serious as the early dispatches indicated. The physicians in attendance reported no bones broken and are confident that he will be able to resume his ordinary routine within a few days. His injuries, which consisted largely of bruises, were very painful, and there is great cause for thankfulness, because of the narrow margin between what might have been and that which is, that this is not an obituary notice instead of a message that his recovery is assured.

Premature Prophesies.—All cross roads of the middle portion of the world's history were said to lead to Rome, and although this would seem to indicate that the engineers of those days were adepts at concentric construction, it nevertheless does not follow that they did not know when it would be good policy to move in a straight line instead of around a circle. In queer contrast to the alleged practice of the "concentrists," some of our later-day constructors seem to have convinced themselves that they are Rome, and that all roads naturally point their way. This belief might be inconvenient in seasons of drought, when roads are liable to be dusty, which is bad for one's vision, with all the unpleasant consequences that can follow an obscuration of the sight. All of which means that it is not wise to tell everything that one knows, even though much time would not be taken up in the telling. Some of the gentlemen who imagine that they are Rome have found it necessary to rush to the fore with the opinion that the Western Association would be better suited this time were the place for holding its annual meeting changed from Louisville to——; well, they did not exactly know where! The ones who so speedily aired their knowledge are not connected with the Western Association in an executive capacity, and so would seem to be fairly open to the charge of intermeddling—perhaps 'twas the dust from the roads which encircle them that clouded their perception. It is true that the executives of the Association, in their anxiety to make assurance doubly sure, did counsel among themselves as to whether Louisville's capacity (under the circumstances) for absorbing a very large number of transients, and putting them at their ease in their inns, was likely to be overtaxed, and it is also certain that the aforesaid executives were the only ones who had any right to put their doings in this respect forward publicly. The time for such announcement came to hand, and Secretary Littleton promptly, in a special circular published to-day, tells what was done and why it was done. Even people who live in the center of the cross roads ought to respect constituted authority, and should refrain from trying to blind others with a dose of the dust that enables them to live on in complacency, but with their eyes shut. We cannot add anything to the force or clearness of Mr. Littleton's explanations—they are like himself, big, broad and brave. To President Egner should be given the credit of sagacity, sharpened by his anxiety to cause the coming meeting of the Western to be firmly intrenched in the safety of success, for his action in putting upon Messrs. Barret, Dennis Long & Co., and others of the local committee, the onus of killing rumor by bonding themselves. The Board of Directors, too, should be credited with faithfulness in responding sharply to the call of their superiors in office. There is, as we said in our last issue, complete certainty that all who see fit to visit with the Western at Louisville at the appointed time will comfortably assist at the best meeting the Association has ever held.

The Columbian Land Company's Bill Seems to be Suffering from an Attack of La Grippe.—The Rhode Island Legislature, through its lower branch, decided, on April 28th, to continue the bill to the May session. The motion to continue was offered by Mr. Warwick, of Hannoford, and it was adopted without debate. This we presume, if it does not virtually kill the measure, puts it in a very weak state, from which condition we hope it will never feel the effect of returning vigor. The whole scheme was simply a grab, from the grip of which we hope the recognized gas interests of Rhode Island will never again be threatened.

The Value of Association Meetings.—The third annual meeting of the engineers in the employ of the United Gas Improvement Company was held at the Continental Hotel, Philadelphia, on April 21, 22, 23 and 24, and from all that we can learn of the proceedings, the gathering was a thoroughly profitable one. Very nearly, if indeed not every Company controlled by the parent Company was represented in the convention, and even far away South Dakota responded to roll call in the person of Mr. L. D. Spragle, of the Sioux Falls Gas Light Company. Many subjects of interest were discussed, the presentations being made in the form of set papers and of reports from special committees charged with examining and reporting upon the best means of securing uniformity of practice in certain directions, such for instance as rules for pipe-fitting guidance, including methods of inspection, boiler settings, and so on. General Superintendent Humphreys presided. One feature of the sessions was the dinner given at the Gas Appliance Exchange, on 15th street below Market. The food was cooked by means of gas, in view of the audience, by certain women experts from the Philadelphia Exchange for Woman's Work. The menu was quite elaborate, and from the way in which its courses were disposed of, evidently the guests had their appetites with them. Having failed to receive any information from the United Gas Improvement Company of an official nature, respecting the meeting, we presume the proprietors thereof do not desire to have their proceedings reported. Respecting their wishes in this regard, we mention the meeting merely to show that a Company managed by astute men finds it profitable to gather its engineers together once a year, at its own expense, both for transportation and time, for the purpose of comparing their experiences in the conduct of similar business at widely separated points. If it pays the Company to do this, how can other proprietors of gas works find argument to defend their assertions that Association meetings mean waste of time and money. The hide bound proprietor must go to the wall unless he tries to keep up with the procession.

The Popularity of the Roots Exhauster.—The P. H. & F. M. Roots Company, writing under date of April 28th, says: "We have to report that our gas exhauster business, so far, is very good, and the prospects are that we will have an exceptionally good year. Some of our recent shipments and orders on our books are as follows: Mutual Gas Light Company, Savannah, one exhauster and engine, combined on same bed plate, of a daily capacity of 75,000 cu. ft.; Bartlett, Hayward & Co., for Bristol (Tenn.) Gas Light Company, exhauster and engine combined, capacity 96,000 cu. ft.; Bartlett, Hayward & Co., for Newark (N. J.) Gas Light Company, two exhausters and engines combined, capacity 2,000,000 cu. ft.; also two No. 4 blowers and engines for the Newark Company's water gas plant; Southern Fuel Gas Company, Maysville, Ky., one exhauster and engine combined, capacity 1,100,000 cu. ft.; one exhauster and engine combined, with pipe fittings, gas valves, governor, etc., with capacity of 250,000 cu. ft., for Massillon (Ohio) Gas Company; Peoria (Ills.) Gas Light Company, one exhauster and engine combined, with 16 in. gas and bye-pass valves, pipe fittings, governor, etc., capacity 2,000,000 cu. ft.; for Burdett Loomis, four hot gas exhausters, with engines combined, capacity of each 3,500,000 cu. ft. In addition to these is the large exhauster for the Consumers' Gas Company, of Chicago, mention of which was previously made in the Journal." President Roots and his associates are bent on keeping that factory of theirs going for all it is worth.

Two Interesting Papers.

By Prof. Vivian B. Lewes.

[Read at the April Meeting of the London Section of the Society of Chemical Industry. Reprinted from the London *Journal*.]

THE ANALYSIS OF ILLUMINATING GASES.

Professor Lewes commenced this paper by observing that during the past year he had had to make analyses of coal gas and water gas carbureted with the hydrocarbons obtained by "cracking" various grades of petroleum oil. At the outset he found so many difficulties that he thought his experiences and the conclusions he had arrived at might be useful to others engaged on similar work. Proceeding, he described the methods of analysis devised and perfected by Bunsen as being far too tedious to permit of their being employed for practical purposes; whilst many of the newer processes and forms of apparatus were, he said, so fraught with error that the results obtained were more likely to create confusion than to serve any useful end. After careful consideration, he adopted the form of apparatus introduced by Mr. J. E. Stead, the main principle of which he explained. In the first analyses made with this apparatus, the author was struck by the insufficiency of detail to be found in the various works on gas analysis; and he also discovered that wide discrepancies existed in the results obtained on making several analyses of the same gas. Taking illuminating gas or carbureted water gas, he pointed out that the chief constituents to be determined were hydrogen, hydrocarbons, carbon monoxide, carbon dioxide, nitrogen, and oxygen; while under certain conditions it was important to know the percentages of acetylene, sulphureted hydrogen, and carbon disulphide present. None of the analytical schemes set forth in the text-books gave anything approaching concordant results in his experiments; and although with an ordinary coal gas he was able to get two analyses of the same sample within a few per cent. of each other, carbureted water gas gave such widely different results that it was evident something was radically wrong. The results of the experiments soon showed that, even with common coal gas, the ordinary method of analysis was absolutely useless, as the cuprous chloride employed to absorb carbon monoxide was nearly as good an absorbent for unsaturated hydrocarbons and oxygen as the liquids generally used for their determination; and this was the case whether it was used in acid or ammoniacal solution. A still more serious cause of error applied to all methods of analysis which Professor Lewes had seen suggested. All researches on the composition of coal gas pointed to the presence of ethane, and probably of higher members of the marsh gas series; while in carbureted gases they were undoubtedly present to a far greater extent. Ethane, propane, and butane had all been shown to be present in small quantities. Seeing that ethane gave double, propane three times, and butane four times its own volume of carbon dioxide, it was evident, he said, that exploding with oxygen, and taking the volume of carbon dioxide as representing marsh gas, would undoubtedly give too high results with ordinary coal gas; while with carbureted gas, it would render the whole of the analysis useless. Moreover the free oxygen was next absorbed, and the remainder taken as nitrogen; and the volume of gas was taken as representing the hydrogen in the gas. The result was that the hydrogen was far too low, not only because the volume of marsh gas was too high, but because the residual nitrogen, having to bear the brunt of all the errors of analysis throughout some seven or eight absorptions, was always too high. These errors in the quantity of marsh gas and hydrogen rendered worthless the calculations of the carbon and hydrogen density of the gas, on which great stress had been laid as showing the composition of the hydrocarbons present. On the whole, therefore, it was not to be wondered at, said the author, that no relation had been discovered between the carbon and hydrogen density and the illuminating value of the coal gas.

The author then described a series of experiments which he had made with a view of determining the best order in which to use the various absorptive liquids, and also to find how far an absorbent could be found for the ethane, propane, and butane. Preliminary experiments showed him that these latter were taken up by alcohol, olive oil, or paraffine; the last-named, when properly prepared, being by far the best and quickest absorbent of the three. To make the experiments as definite as possible, solutions of known strength were employed; those which the author found to be the most advantageous being described by him. The gases, he continued to remark, were obtained as nearly pure as was compatible with ordinary manipulative precautions and methods of purification; and the percentage of gas and the nature and percentage of impurities were ascertained—the absorption figures given in the tables being in each case the amount of pure gas taken. Having explained the mode by which he prepared the methane, ethane, ethylene, carbon monoxide, and oxygen, the author said that water was used as the trapping fluid in all the experiments. In each determination, the gas was, after measurement in the eudiometer, run into the laboratory vessel, and allowed to stand quietly for ten and twenty minutes respectively over the absorbing fluid, the amount taken up being measured at the end of each period; whilst in a second experiment, the absorbent liquid was kept agitated for the same length of time in contact with the gas. The following table (which was exhibited in the room) contains the results of the experiments:

Absorbent.	Still.		Agitated.	
	10 min.	20 min.	10 min.	20 min.
Ethylene.				
Nordhausen acid	6.2	7.80	97.0	100.0
Fuming nitric acid	9.4	9.87	93.5	93.5
Bromine in potassic bromide	99.2	100.00	100.0	100.0
Alcohol	17.0	56.70	75.0	57.0
Paraffine	53.1	62.50	87.5	75.5
Acid cuprous chloride	44.6	55.50	94.4	100.0
Amm. cuprous chloride	....	....	....	....
Alkaline pyrogallate	....	....	....	....
Sodic hydrate	37.5	50.00	93.7	93.7
Ethane.				
Alcohol	46.4	60.7	89.2	89.2
Paraffine	82.1	89.2	100.0	100.0
Olive oil	10.7	17.8	92.9	96.4
Bromine in potassic bromide	....	....	....	....
Fuming nitric acid	....	....	6.4	53.6
Nordhausen acid	....	....	....	....
Acid cuprous chloride	....	....	....	....
Amm. cuprous chloride	....	....	....	....
Alkaline pyrogallate	....	....	....	....
Sodic hydrate	....	....	....	....
Methane.				
Alcohol	11.2	16.9	43.9	57.8
Paraffine	19.6	36.9	64.2	66.7
Olive oil	2.5	2.5	11.5	25.5
Bromine in potassic bromide	....	....	....	....
Fuming nitric acid	....	....	5.78	11.5
Nordhausen acid	....	....	....	....
Acid cuprous chloride	....	....	....	....
Amm. cuprous chloride	....	....	....	....
Alkaline pyrogallate	....	....	....	....
Sodic hydrate	....	....	....	....
Carbon Monoxide.				
Acid cuprous chloride	83.1	90.0	98.8	100.0
Amm. cuprous chloride	35.5	57.7	97.7	100.0
Nordhausen acid	....	....	....	....
Bromine in potassic bromide	....	....	....	....
Fuming nitric acid	....	....	4.8	4.8
Alkaline pyrogallate	....	....	....	....
Sodic hydrate	....	....	....	....
Paraffine	....	....	....	....
Alcohol	....	....	....	....
Oxygen.				
Alkaline pyrogallate	84.2	88.4	92.6	100.0
Acid cuprous chloride	25.2	50.5	71.5	88.4
Nordhausen acid	....	....	....	....
Bromine in potassic bromide	....	....	....	....
Fuming nitric acid	....	....	....	....

The author pointed out that these experiments showed that none of the absorbents used could be employed to separate ethane or other members of the paraffine series from the methane, as the latter gas was soluble in all of them. Some further experiments, however, showed that, in mixtures of ethane and methane, contact with paraffine, with occasional agitation for from twenty to thirty minutes, removed all ethane and a large proportion of the methane, the remainder of which could be determined by explosion and estimation of the carbon dioxide formed—the volume absorbed by the paraffine, *plus* the volume of carbon dioxide produced on explosion, giving the total volume of saturated hydrocarbons. Reference was here made to experiments with the unsaturated hydrocarbons, which showed that it was not possible, by any of the absorbents at present in use, to effect a separation. The author then stated that his experiments clearly fixed the order in which the absorptions must be made, but only gave a general indication of the time necessary to complete the estimation of small quantities of any particular gas in the presence of a large volume of diluents. This he had attempted to determine by making and analyzing mixtures containing known volumes

of the various gases; and the general scheme of analysis which gave him the best results was as follows: Two carefully calibrated Stead's apparatuses were taken—one containing mercury as the trapping fluid, the other water, over which all the ordinary absorption analyses might be made; the mercury apparatus being kept for explosion and subsequent estimation of carbon dioxide. (1) Carbon dioxide and sulphureted hydrogen were first absorbed by 50 per cent. sodic hydrate solution; ten minutes' agitation being sufficient to complete the absorption. (2) The oxygen was next absorbed; 20 minutes being, as a rule, needed to complete the absorption. (3) The unsaturated hydrocarbons were then estimated by absorbing with a solution of bromine in potassic bromide, and the action completed in fifteen minutes with gentle agitation. Bromine vapor was absorbed before measurement by agitation with sodic hydrate. (4) Carbon monoxide was next absorbed by acid cuprous chloride, which, the author remarked, must not be used more than twice with gases containing 20 per cent. or upwards of monoxide, nor more than four times with ordinary coal gas. As much as could be absorbed would be taken up in 20 to 30 minutes with agitation. (5) The saturated hydrocarbons were now partly absorbed by paraffine oil; 30 minutes being required to ensure complete removal of the last traces of ethane, butane, etc. A portion of the remaining gas was run into the mercury eudiometer, measured, mixed with excess of oxygen, and exploded; the carbon dioxide formed being then absorbed over sodic hydrate—giving the volume of methane unabsorbed by the paraffine. He mentioned that in exploding, the taps of the apparatus should be secured by an india-rubber band, as the shock sometimes loosened the cock, and caused a leakage. (6) Having determined the gases soluble in sodic hydrate, the oxygen, unsaturated hydrocarbons, carbon monoxide, and saturated hydrocarbons, it would be quite allowable to absorb excess of oxygen by alkaline pyrogallate, and take the residual gas as nitrogen, calculating the hydrogen by difference. It must be remembered, however, that in each observation some small error had crept in, and the total of these having to be borne by the residual gas of ten operations brought out the nitrogen far too high. To eliminate this error as far as possible, the author said he started with a fresh measured volume of the gas, mixed it with a large excess of oxygen, and exploded over mercury, and then treated the residual gas with a strongly alkaline pyrogallate for 20 minutes; keeping it well agitated in contact with the gas. This absorbed both carbon dioxide and excess of oxygen; and an accurate determination of the nitrogen was obtained. The analysis so far was as follows: (1) Carbon dioxide and sulphureted hydrogen; (2) oxygen; (3) unsaturated hydrocarbons; (4) carbon monoxide; (5) saturated hydrocarbons; (6) nitrogen; and (7) hydrogen, by difference. With ordinary manipulative skill in transferring the gases from the eudiometer to the absorption vessels and back again, the results would be fairly accurate; the carbon monoxide, however, being from 0.5 to 1 per cent. too low; and, in consequence, the saturated hydrocarbons the same amount too high.

In the next portion of the paper, Professor Lewes said that to complete the analysis with ordinary coal gas, and to trace the action going on in many forms of carbureting apparatus, it was necessary to be able to estimate the butylene, sulphureted hydrogen; and other sulphur compounds which were likely to be present in minute traces, and which could not be determined by any volumetric method of the above character. He described in detail a process for doing this as proposed by Winkler, and then concluded by saying that up to now he had found no simple and reliable method for the separation and estimation of the various hydrocarbons present in illuminating gas, and, until this was done, gas analysis could not be of its full value in helping to clear up many points which were still difficulties in the complicated question of carbureting gases. He hoped, however, that the work he had brought before the Society would be a help to others who, like himself, had had to take up the subject of the analysis of illuminating gases; as although such a method as he had described left much to be desired, it gave fairly correctly the salient points of importance to the gas manufacturer and consumer. Two such analyses could, with good management, be made in a day, so that the amount of time expended was not prohibitive; and he could not help thinking that, if some of those gentlemen who claimed to be able to make an analysis of an illuminating gas in something under an hour, were to check their methods on known mixtures, they would be considerably startled at the results.

In the course of the discussion which followed the paper, Mr. T. S. Lacey said he did not suppose there were many gentlemen present who had made analyses of illuminating gas; but he thought that any one who had had anything to do with this difficult branch of analysis would feel very deeply indebted to the author for the work he had carried out. The text-books seemed to treat the subject as being very simple; and one would imagine from reading the descriptions of the processes that they could be carried out with the most marvellous accuracy. But when they came to actually do the work, and especially if they did this very rare thing—attempt to repeat their analysis under slightly different circumstances, they found that discrepancies occurred. Finding out the conditions which caused these discrepancies was the important point. One of the most difficult things was to know how much oxygen to mix with any gas in order to cause its perfect combustion without acting upon the nitrogen present in the mixture. With a residual gas, they were uncertain as to how much oxygen to use and what pressure to explode it at; and if Professor Lewes could give them some information on this point, it would be very valuable. With too large an excess or too small an amount of oxygen, different results were obtained. There was one possible mixture which would give tolerably accurate results; but it was very difficult to know whether or not one had complete combustion. Then with regard to the question of absorbing the gases of the methane series. When sulphuric acid was the absorbent used, none of the paraffines were absorbed; and they constituted an important part of the mixture, and might very much affect the illuminating power. The figures in the paper would be of great use to those who had to perform any of these analyses; and if Professor Lewes could give them further details, they would constitute a valuable addition to the limited amount of information that existed at present on this subject. He would like, in conclusion, to ask one question—that was, how the bromine was used, and could it be used over mercury?

Professor Lewes replied that the absorptions were all made over water. He only used mercury-trapped eudiometers for estimating the carbon dioxide in the gas.

Professor W. Foster dealt at some length with various points raised in the paper. He remarked that it was interesting to hear the author recounting the difficulties that one met with in making gas analyses—difficulties which he (the speaker) had encountered some six or seven years ago; but he believed that Professor Lewes would have to modify some of the assertions he had made. Sulphuric acid he had found was a perfectly good absorbent; and he did not think the author would improve upon it as an absorber of hydrocarbons. He had spent some considerable time in trying to get rid of Nordhausen acid, and had come to the conclusion that it was probably possible to replace it.

Professor Lewes, in reply, said he thought Mr. Lacey had brought forward one or two good points; one being the conditions under which they had the explosion taking place, and how those conditions were to be modified so that there should not be any oxidation of the nitrogen going on at the same time as the explosion. He believed Mr. Lacey would agree with him in this—that the absorption of the higher paraffines was a very distinct step in this direction. If they absorbed the higher paraffines, and had only the marsh gas to deal with, and knew approximately the amount, they could put in nearly the quantity of oxygen required to combine with it. With reference to Mr. Foster's remarks, he was quite sure that, having made a large number of gas analyses, he must have come across the same difficulttes as he had himself.

THE ANALYSIS OF THE PRODUCTS OF INCOMPLETE COMBUSTION.

In his opening remarks in the second paper, Professor Lewes said that the methods of analysis which served to separate and estimate the constituents in an ordinary gas failed altogether to detect the presence of minute traces of such gases as methane, hydrogen, acetylene, and carbon monoxide when mixed with large volumes of inert gases such as nitrogen; and moreover, as these four gases offered great difficulties of separate estimation by any combustion processes at present in use, the determination of them in the products of incomplete combustion escaping from flames which were used for heating cold surfaces, had hitherto proved unsuccessful. Alluding to the paper read at the last meeting of the British Association on the products of incomplete combustion of gases given off from gas stoves, he said that the author (Mr. W. Thomson) endeavored to separately determine the quantity of carbon monoxide and hydrocarbons in the flue gases; but, like most other observers who had tried to do this, he found it so beset with difficulties that he abandoned the attempt, and contented himself with determining the total quantities of carbon and hydrogen escaping in an unburnt condition. The experiments showed that the combustion of gas in stoves had been far less complete than had been imagined; but unfortunately they gave no idea as to whether the carbon and hydrogen were present with the products of combustion simply as such harmless constituents of the gas as methane and hydrogen, or whether they were there as the highly-poisonous products of incomplete combustion—acetylene and carbon monoxide. For some time past the author had been trying to utilize

the well-known property which palladium had, of causing the oxidation of hydrogen (but not of methane) when a mixture of these two gases with air was passed over it as a separation between them. The carbon monoxide present, however, would have been a difficulty in the way of doing this had not experiments shown that it was oxidized to the dioxide under the same conditions as brought about the oxidation of hydrogen when passed over heated palladium asbestos. It was necessary to try by experiment whether, during the slow passage of a large volume of the products of combustion through a heated tube containing a considerable quantity of palladium asbestos, a satisfactory combustion of the carbon monoxide and hydrogen could be obtained, without at the same time interfering with the methane present, as, if so, the acetylene could be absorbed first of all in the usual way by ammoniacal silver nitrate, the carbon monoxide and hydrogen estimated by combustion in contact with palladium asbestos, and the methane determined by further combustion in contact with platinized pumice.

Having described the manner in which the palladium asbestos and the platinized pumice stone were prepared, Professor Lewes referred to the methane, carbon monoxide, and hydrogen used. The percentage of true gas in each of these was carefully determined, and a mixture was made containing 3.60 per cent. of hydrogen, 71.31 per cent. of air, 20 per cent. of oxygen, 4.30 per cent. of methane, and 0.79 per cent. of carbon monoxide. This mixture was confined in a carefully graduated glass bell jar over water; and after being carefully freed from any trace of carbon dioxide, by passage through caustic potash, and dried by calcium chloride, it was passed through a small combustion tube (10 inches in length) containing the palladium asbestos, heated by three spirit lamps placed 3 inches below it, the carbon dioxide and water so produced being collected in a series of absorption tubes, giving the carbon monoxide and hydrogen present in the gas. The residual gas passed on over the platinized pumice, heated to a high temperature by a series of Bunsen burners; the products of combustion being collected in another set of absorption tubes. Three analyses of the mixture gave the following results, which were not considered to be very satisfactory:

		I.	II.	III.	Actual.
Hydrogen		3.00	3.84	3.28	3.60
Methane	From (H_2O) water	4.70	5.00	5.19	4.30
	From carbon dioxide	3.95	3.82	3.47	
	Mean	4.32	4.40	4.33	
Carbon monoxide		0 30	nil	0.58	0.79

The mean of methane, the author pointed out, agreed fairly well; but the hydrogen and carbon monoxide results were unsatisfactory. He then tried other experiments, in which he varied the distance of the spirit lamp flames from the tube containing the palladium asbestos; and it was shown that, up to a certain degree, increase of temperature gave greater accuracy in the results. When, however the heat was too strong, traces of methane were decomposed, and made the carbon monoxide and hydrogen results too high. Therefore he thought it was evident that, in order to obtain a reliable process of analysis, means must be taken to accurately regulate the heating of the palladium asbestos; and this was done by bending the tube containing it into V-shape, and heating it in a bath of melted paraffine wax. After many experiments at various temperatures, the author found that 210° to 220° C. gave the best results. For example—

	Taken.	Found.
Hydrogen	1.83	1.83
Methane	1.71	1.76
Carbon monoxide	1.50	1.47

Having obtained a reliable method for analyzing small traces of these gases the process was employed for determining the composition of the gases, escaping into the atmosphere when the flame of an atmospheric burner was brought into contact with the bottom of a vessel which was kept cool by water between the temperatures of 0°C. and 100°C. No flame was in contact with the substance which it heated unless the latter was at the same temperature as the flame itself. This was due to the fact that the substance being heated, by conducting away the heat from the flame, practically played the same part as the gauze of a safety-lamp, and so cooled down the flame that the ignition point of the gas was not reached in the immediate neighborhood of the heated surface. The flame was thus extinguished for a certain distance from the bottom of the vessel; and the extinguished flame gases crept along the cooling surface, and finally escaped into the air.

After a number of attempts to devise a form of apparatus which would allow the products of combustion to be collected without at the same time giving too great an admixture of air or interfering with the process of combustion going on, the author arrived at the conclusion that the best form of apparatus to use was a tin-lined copper pot. A specimen of this apparatus was exhibited; and Professor Lewes proceeded to describe it. The bottom of the pot, he said, had a false bottom, which gave a space of an inch between the two bottoms. In the center of the false bottom was an aperture 2½ inches in diameter; and fitted into the side of the lower compartment was a ½-inch exit-tube. Putting a known volume of water at 0°C. into the vessel, and placing a Bunsen burner with a flame of carefully regulated size below it, so as to allow the flame to pass through the hole in the false bottom, and impinge on the bottom of the vessel itself, it was possible to draw off products of combustion from the exit-tube without having a larger volume of air than necessary mixed with it. On leaving the tube, the gases were passed through fused calcic chloride, which had been previously treated with carbon dioxide, to prevent any free alkali being present; and the increase in weight of these tubes gave the water vapor produced by the combustion. The gas then passed on through tubes containing caustic potash to absorb carbon dioxide, and then through a tube in which a sample could be taken for determination of the oxygen; while the acetylene was next estimated by passing the gas through two absorption flasks containing ammoniacal silver nitrate. Next came the palladium asbestos tube heated to 220°C. in a paraffine bath, and the U-tubes containing the calcic chloride and caustic potash for estimating the water vapor and carbon dioxide formed. Then followed the platinized pumice heated by a flat-flame burner nearly to the softening point of the combustion tube. Beyond that was a trap-tube of calcic chloride. And, lastly, aspirating vessels. In these the volume of gas sucked through could be measured; and after correcting for temperature and pressure, the volume of gas absorbed in the experiment could be added—giving the total volume of products of combustion drawn through. With this apparatus the author tried an experiment on a mixture of known composition, which showed that an excess of oxygen must be mixed with the products of combustion in order to give satisfactory results with low forms of combustion as those taking place in the palladium asbestos tube; and a carefully measured quantity of pure oxygen was then made to flow in a steady rate to the second acetylene absorption bottle, so as to mingle with the products of combustion before passing over the palladium asbestos—the gas being kept in a carefully graduated glass bell jar, so that the volume used could be abstracted from the total volume of gases after correcting for the amount used in the various combustions. In this way, the products given off when the vessel was heated at a point ½-inch above the inner zone of the flame, and also the top of the flame, were determined. The results of this experiment were given in a table included in the last of the series of Cantor Lectures delivered by Professor Lewes at the Society of Arts in December last. The figures showed that the extreme tip of the atmospheric burner was the only portion of a flame which could be utilized for heating substances cooler than itself without giving rise to deleterious products of incomplete combustion. These results were corroborated by analyzing the gases escaping unburnt from the outer zone of a luminous flame and an atmospheric burner flame respectively. The figures arrived at by the author in these analyses were also given in the lecture mentioned above; and they showed that the air mixed with coal gas in the atmospheric burner produced far more complete combustion than in the case of luminous flame. He also quoted the results that Dr. Blochmann obtained in experiments upon the composition of gases present in various parts of the Bunsen flame; and these were likewise embodied in the lecture previously referred to. They tended to show that the flame of an atmospheric burner could not be used for any heating purposes without the escape of deleterious products, except at the extreme tip where combustion was completed. Therefore in all forms of gas-heating apparatus, it was the hot products of combustion and not the flame itself which should be employed as the source of heat, unless thorough ventilation could be obtained and none of the gases from checked combustion were allowed to find their way into the atmosphere of the room.

In the course of the discussion, Dr. Thorne said that the members were grateful to Professor Lewes for having brought before them the interesting results contained in his paper. The subject was of immense importance, and perhaps more so at present than it had ever been, when the use of gas for heating purpose was becoming so much extended, and, if one could judge by experience, would become still more extended in the near future. This question of incomplete combustion was one of the most serious points in the use of gas as a heating agent. He supposed there were very few—he might almost say no heating stoves at present in use that were perfectly innocent in this matter. The greater number of heating stoves that were sold were simply abominable. The prejudices against using gas as a heating agent were to a large extent due to the fact that the question of incomplete combustion had not been sufficiently recognized; and manufacturers of stoves had taken no

account whatever of the conditions that should be carried out to produce stoves free from danger and contamination of the air of the rooms in which they were used. He thought Professor Lewes's results were most interesting; and the apparatus he had employed in his experiments was admirably suited to the work he had been performing. He had obtained an analysis of the products of combustion on the surface of the flames in a way that had never been carried out hitherto, and had been able to differentiate the products of the different parts of the flames by a plan which would be of great importance.

Mr. Bertram Blount pointed out that Professor Lewes had not given them any data in his paper on which to condemn gas stoves. If he could give them an analysis of gas drawn from the neighborhood of the flames in thoroughly well-made gas stoves or any other form of heating apparatus—if he could give them an analysis of the gas given off at the point where the Bunsen flame played upon a refractory substance—then they would be able to say whether gas stoves did or did not incompletely burn the gas. Besides there was this little difficulty in his experiments—in order to collect the gases, he had recourse to the device of a false bottom. He did not know that a better plan could have been adopted; but it appeared to him that, even with the careful regulation that the author had spoken of, there must be some mistake in checking the combustion, and the Bunsen burner would consequently show up worse than if it were burning freely without any such restraining influence.

Mr. Lacey said he should like to confirm what the last speaker said as to the great importance of the method in which the products of combustion were collected. If the flame was at all affected by the casing—as he certainly thought it would be—it must limit the amount of air that would pass under ordinary conditions; and, of course, this meant that the results were not exactly what would be obtained if the gas was burned under a copper pot in the usual way. The same objection applied to some extent to the difficulty of collecting gas from any flame if its normal action were interfered with. He knew that the difficulties were very great; and he could not but say that the author had exercised every care he could be expected to do, in order to avoid errors. He thought it was possible that the normal action of the flames had been interfered with by the method of collecting the products of combustion. Professor Lewes had shown them a method by which they could analyze these gases, and which could be applied by anyone who had a knowledge of chemistry. It would have been very satisfactory if it had been possible to test the actual products of the combustion of the flames (say) from a gas stove; and given an analysis of them.

Professor Foster said that the subject before the meeting was of the greatest importance at the present time, seeing that there was such an enormous development in the use of gas for heating purposes. Now what was the condition of things (say) in the case of the effluent gases coming out of the cylinder of a gas engine. The condition of things was briefly this—that, if the gas was in course of combustion, whether there was oxygen in excess or not, it was of little moment, if the flame was surrounded by a cold substance. The matter with which they were dealing was brought under the notice of Mr. Dibdin and himself at the exhibition held a few years ago at the Crystal Palace; but it was a matter of regret that they had not then an opportunity of investigating it. The nature of the mixtures of course determined what the nature of the effluent gases would be. The more hydrogen there was in the mixture, the less would be the carbonic oxide produced.

Dr. Wright said there was one point which occurred to him. Various forms of stoves were in use in which the products of combustion came in contact not with fireclay, but with iron, which became coated over with a film of oxide. He could not say he had carried out any very extended observations, but what observations he had made led him to believe that much more perfect combustion was obtained with this surface than when the flame played on clay or such like material. With reference to the table showing the gases escaping during checked combustion, he asked what had become of the oxygen which was associated with the nitrogen in the air.

Professor Lewes said the oxygen was estimated from the amount taken out of the tube, and the amount of nitrogen belonging to it as air was deducted so as to give the products of combustion without mixture with air. The oxygen was analyzed, its proper quantity of nitrogen was then deducted from the total nitrogen found, and this gave the amount of nitrogen and hydrogen left. The proposition as to heating iron with flame, he had not had an opportunity of judging; but it sounded very reasonable indeed. Dr. Thorne, who opened the discussion, treated him (Professor Lewes) very kindly, but the gas stove manufacturers, he thought, a little harshly. The whole trouble was this: In order to make a gas stove which should give off merely harmless products of combustion, only the extreme tip of the Bunsen burner should be used if the highest results were required; but if they were to ask a gas stove manufacturer to construct a stove under these conditions, he would simply laugh at them. All the time more was expected of gas stoves than could possibly be obtained from them, they would continue to have the noxious products given off. There was not a single gas stove made, the products of combustion from which should be allowed to enter the room; and where gas stoves were used, there must be perfect ventilation. Mr. Bertram Blount said that he (Professor Lewes) had not given any figures as to the heating effect of flames on refractory materials; but that was a question he was not dealing with. It did not much matter whether they heated asbestos or any substance up to the point of ignition; in every case these products of incomplete combustion would be given off. As the temperature rose, the percentage of incomplete products, however, became less. Mr. Lacey made an admirable remark as to the limitation of combustion such as must take place in a vessel like that used in the experiments. This was a difficulty which was present in his mind; but he thought Mr. Lacey would find that the products were not so much increased as might be expected. In the experiments, he used a small flame, so as not to fill up the hole in the false bottom. There was thus a free space round the flame; and therefore the interference with it was as small as one could well get.

A vote of thanks was passed to Professor Lewes for his very instructive papers.

The Incandescent Lamp.

[A paper read by Mr. Thos. G. Grier, before the Chicago Electric Club.]

Incandescent lighting is now merging into a second decade of commercial life, and any neglect on the part of the electrical fraternity to fully understand the importance which the incandescent lamp plays in this growing industry, is suicidal to their interests.

The subject is entirely too large to treat comprehensively in a limited article, but a few points will be brought forward that, it is hoped, will promote discussion and bring forth valuable information from members of the club.

Though ten years have hardly passed since incandescent lighting has been an acknowledged possibility, the birth of the lamp has been recorded for nearly half a century. Platinum wire heated to incandescence seems to have been the earliest form of the incandescent lamp, and was experimented with even as recently as 1885. In 1845 we read of experiments with carbon sticks and pencils inclosed in glass globes, that were either filled with some non-active gas or had the air exhausted and the carbon surrounded by a vacuum.

The march of invention, at last, in 1879, reached a point at which the public was assured that a new era of artificial illumination would be upon them, and so authoritative was this assurance that the gas stocks all over the country declined in value. It was not, however, until the year 1880 that any definite information as to the electrical properties of the incandescent lamp was determined, and in 1881 incandescent lighting was no longer a laboratory phenomena, but was merging into an industry, the proportions of which at the present day are hardly realized.

The Franklin Institute of Philadelphia, in view of the advance in the application of electrical science to commercial uses, discussed the advisability of holding an electrical exhibit, and in the fall of 1884 the desire and anticipation of the members of the Institute were accomplished.

The limited knowledge of and the absence of any reliable data on incandescent lamps led the Institute to invite the manufacturers to place samples of their lamps in the hands of an impartial committee of experts for a comparative test. The results were published in September, 1885, and from the official report a few facts have been compiled.

Five different manufacturers submitted their lamps, some submitting several batches of different voltages. The lamps were tested for duration or life, and before placing on test their initial efficiency per spherical candle power was determined.

The following tabulated data is of six sets of lamps:

Make.	Average life.	Voltage.	Initial efficiency per spherical c. p.	Loss in c. p.
Weston	454 hours.	111	3.63	50 per cent.
White	274 "	50	4.08	? " "
Woodhouse & Rawson	290 "	55	5.56	33 " "
Stanley	430 "	96	3.92	37 " "
Stanley	294 "	44	3.45	34 " "
Edison	1026 "	97.9	4.48	35 " "

From the results as given in the table, it will be seen that the greatest depreciation in candle-power was 50 per cent., and the least, 33 per cent.

This, however, can not be taken for any comparison, as the life of the lamps showed such a great disparity. The depreciation of the Edison lamps, which proved the superior in the test, was 35 per cent. These results are looked upon to-day as of little practical value except as historical record, but they have taught us that lamps are a delicate matter to handle, and whether a lamp possesses value depends on many circumstances. These results were a valuable round added to the ladder of knowledge, and it is hoped that experiments of a like nature, yet of more practical value, will be made in the near future for the benefit of the incandescent lighting plants and the men interested in incandescent lighting.

Since 1884 many other makes of lamps have come on the market, and knowledge gained by experience has both improved the quality of the lamps and cheapened the process of manufacture. In 1884, lamps were advertised, 16 candle power, $3; to-day from 40 cents to 60 cents may be taken as an average price.

Six years now have passed since the Franklin Institute experiments, and we are almost as much in the dark as in the earlier days of the industry. The question of life seems to be the most important factor to be considered from the central station point of view, and to meet this desire various manufacturers frequently guarantee the average life of their lamps. Those guaranteeing the longest life and at the same time proving their guarantee, usually get the majority of the business.

From time to time we hear of some remarkable lamp whose life has run into the thousands of hours, and often have I heard the veracity of a man's statement questioned when he has given some facts in regard to long lived lamps. In my own experience I can relate of a lamp burning from seven to ten hours a day for six years, which would mean a minimum life of 13,000 hours. Yet, to make this statement offhand to the general public, and even to the electrical fraternity, it would be received with doubt. There is not, however, the least trouble in making an incandescent lamp for any desired life. The life of a lamp depends upon the efficiency at which it is burned.

John W. Howell, in 1888, published a statement based upon the experiments of the Edison Company, which covered five years of time and the use of thousands of lamps. In this statement he says the life of a lamp burned at two watts efficiency was practically zero; at three watts per candle it was 1,000 hours: at four and three-fourth watts per candle power it was 16,000 hours. This at once shows that the question of life is merely a question of circumstances and may or may not be advantageous. He also stated in the same paper that the candle power of any lamp depends upon the efficiency at which it is burned. An Edison lamp gave five candle power when run at 6.7 watts per candle power, and when the efficiency was increased 2.66 watts, the candle power was increased to twenty, this variation depending upon the electromotive force operating the lamps.

These statements show that the Edison lamps follow a law. All makes of lamps follow the same general law, each having its own especial curve, and it is this curve that gives the average quality of the lamp.

The object of an incandescent lighting station is to produce light. It is necessary to develop electrical energy, but it is the lamp that transforms this electrical energy into light. The electrical energy represents the dollars of the investor and operators of the station, and it is most important that it should be used with the greatest economy to obtain proper reward for the investor.

This must needs bring into the question the lamp used—the life, the cost, and the efficiency being the three considerations.

To bring the matter to a point at once, we will assume conditions which are perfectly feasible and within the bounds of possibility. First, we will consider that a lamp burning at 4½ watts efficiency will depreciate but a minimum for the first 1,000 hours. We will consider this lamp and the cost of operating it. A lamp at 4½ watts efficiency and 16 candle power burning for 1,000 hours would require a total expenditure of electrical energy of 72,000 watt hours. This at one cent for 50 watt hours would be $14.40 for the current, and adding 50 cents for the cost of the lamp would make a total cost of $14.90 for burning this lamp for 1,000 hours. The efficiency of another lamp is 3½ watts per candle power. We will not say how many lamps will have to be replaced in the 1,000 hours, but just assume that the efficiency of 3½ watts per candle power is maintained throughout the 1,000 hours. The total expenditure of energy on this basis will be 56,000 watts hours, which will cost, at the rate of one cent for 50 watts hours, $11.20. Adding 50 cents to this for the cost of the first lamp, makes it $11.70, leaving a difference in favor of the 3½ watt lamp of $3.20, which, of course, will have to be used to a certain extent in replacing the lamps, but allowing that a 3½ watt lamp will maintain its efficiency for 333 hours, we will merely have to pay $1 additional for replacing lamps and have a net saving of $2.20. This, though an assumption, is not distorted, for lamps from 3½ to 4½ watts' efficiency are on the market, and yet, many a station is being operated with lamps of a worse efficiency than 4½ watts, and they wonder why it is that their dividends are smaller than those of other plants. It is the incandescent lamp that will make or break the dividend paying record of the central station and it should be considered with the utmost care. The assumption has been made and the question been analyzed. The lack of actual data makes it necessary to assume and analyze the question as it has just been done. However, the London *Electrical Review* has published some facts which will be analyzed as this assumption has been, and will show immediately the advisability of maintaining efficient lamps on a circuit, even though their life be short.

The facts published by the London *Electrical Review* were an account of a test on Edison-Swan lamps, and the results were presented in tabulated form, giving the initial candle power, the initial efficiency and the total watts used on the lamp. A test of 1,000 hours' duration was started and at the end of each 100 hours observations were made as to the candle power and the total energy, the efficiency of the lamps being computed and placed in the table. This table is presented to you in this article with the deductions drawn from the data as given—the first four columns of the data as furnished by the *Electrical Review*, the other columns are deductions drawn from the first four columns.

Table B.

Hours.	Candle Power.	Watts per Candle Power.	Total Watts.	Average of each 100 Hours. Average Candle Power.	Average Total Watts.	Cost Figured on the Basis of 1 Cent for 50 Watt Hrs. For each 100 Hrs.	Of 16 C. P. at 100 Hrs.
0	19.3	3.34	64.46				
100	18.8	3.45	64.86	19.05	64.66	$1.293	$1.08
200	17.2	3.79	65.19	18.00	65.03	1.300	1.16
300	15.6	4.10	63.96	16.40	64.57	1.297	1.26
400	15.2	4.17	63.38	15.40	63.07	1.270	1.32
500	14.8	4.29	63.49	16.00	63.44	1.268	1.35
600	14.4	4.38	63.07	14.60	63.28	1.264	1.38
700	14.1	4.50	63.45	14.25	63.26	1.265	1.42
800	13.3	4.68	62.24	13.70	62.85	1.257	1.47
900	12.4	4.90	60.76	12.85	61.50	1.230	1.53
1,000	12.0	5.00	60.00	12.20	60.38	1.207	1.58

Column seven shows what the customer pays each 100 hours for the lamp he is using. Column eight shows what he pays for each 16-candle power of light he gets for each of the 100 hours. These figures are computed upon the average of the observations; that is, for the first 100 hours the average candle power produced is taken, and so on, for each succeeding 100 hours. The cost of the electrical energy used in the estimate is one cent per 50 watt hours, the prevailing price at the present day.

The potential in these experiments was constant, the same as any ordinary central station endeavors to maintain. The resistance of the filament increases as the lamp continues to burn, and the total energy used, when the potential is constant, decreases and the lamp takes less current to a small extent than when it starts to burn. The relation of the candle power to the total energy shows, though less energy is used as the life continues, that the economy of the lamp is greatly lessened because the light produced decreases (due to the depreciation of the filament and the discoloration of the glass) in a much greater proportion than the total energy.

As the light decreases in a much greater proportion than the energy, which is what we pay for, the light being the result, however, that we desire, it is easy to see that we are paying more for our light as the lamp continues to burn.

If we wish to maintain a constant candle power throughout the entire life of a lamp, the electromotive force will have to be raised as the filament increases in resistance. The discoloration of the glass and the depreciation in the quality of the filament also make an additional increase in the electromotive force necessary; the current is maintained up to what it was at the start, and even increased. Thus the energy required to produce a constant supply of light would be constantly increasing, and therefore the cost of the light constantly increasing as the life of the lamp continues.

Dr. Philip Atkinson, of Chicago, in a recent lecture in which he advocated the economy of the renewals of incandescent lamps at much shorter intervals than the usual practice, unfortunately gave as the reason that the filament's resistance was reduced the longer the lamp was used, whereby the current is increased, while at the same time the luminosity is decreased.

He is wrong in regard to the resistance of the filament and the in-

crease of current, for the incandescent lamp as it grows old takes less current whenever the potential is constant.

Attention is called to Dr. Atkinson's reason, so that others may not be misled by his incorrect premises, even though they may have been used to prove an assumption that is supported by facts. There is nothing so detrimental to a cause as false and incorrect premises.

The financial results in Table B. are very clear and plain, and anyone would say at a glance, allowing that a 16 candle power lamp costs 50 cents, that it would not cost the consumer a cent more for light if he bought a new lamp at the end of 900 hours, for the saving in current would pay for the lamp; that much is apparent. However, the following table makes the matter clearer, and more closely defines the line of the most economical life of the lamp. The lamps are assumed in this table to cost the consumer 50 cents: the cost of the current is taken from the table just previous to this.

Table C.

Number of Hours to Burn.	Cost of Current for 16-C.P.	Cost of Lamps.	Total Cost Current and Lamps for 1,000 Hrs.
Lamps replaced every 100 hours	10.80	5.00	$15.80
Lamps replaced every 200 hours	11.20	2.50	13.70
Figured on a basis of 1,200 hours, and reduced to 10 12. Lamps replaced every 300 hours.....	11.66	1.66	13.82
Figured on a basis of 1,200 hours, and reduced to 10-12. Lamps replaced every 400 hours	12.05	1.25	13.30
Lamps replaced every 500 hours	12.34	1.00	13.34
Figured on a basis of 1,200 hours, and reduced to 10-12. Lamps replaced every 600 hours.....	12.68	.83	13.51
Figured on a basis of 1,400 hours, and reduced to 10-14. Lamps replaced every 700 hours.....	12.81	.71	13.52
Figured on a basis of 1,600 hours, and reduced to 10 16. Lamps replaced every 800 hours..... ..	13.05	.62	13.67
Figured on a basis of 1,800 hours, and reduced to 10-18. Lamps replaced every 900 hours.....	13.30	.55	13.85
Lamps replaced every 1,000 hours.....	13.55	.50	14.05

The result of the above compilation shows that for this grade of lamp at the price of current and the price of lamp assumed, that though the lamp will last 1,000 hours it is better to throw the lamp away at the end of 400 hours and use new ones. Seventy-five cents per lamp will be saved every 1,000 hours by replacing the lamps every 400 hours instead of keeping one lamp in 1,000 hours.

If the lamps were cheaper and the current the same, or dearer, it would be cheaper to replace the lamps still oftener than 400 hours. If the current was but half of what is assumed in the compilation, that is, if the current cost but 1 cent for 100 watt hours, it would be cheaper to replace the lamps every 700 hours, cheaper by about 17 cents for every 1,000 hours.

It is not a question of the life of a lamp alone, that should determine what lamps should be used, but also the efficiency of the lamp, cost of current and price of lamp.

A mathematical equation should be formed taking all these factors into consideration before the matter should be decided by the central station. Reliable data on the majority of the makes of the lamps are not obtainable, and it has been necessary to treat the matter from assumption and from analyzing such data as have been published; but even from mere assumption it is, without doubt, an assured fact, except when the current is extremely cheap, that an efficient, short-lived lamp is preferable to an inefficient long-lived lamp.

In making this mathematical equation the end in view is to determine the efficiency at which the sum of the costs of power and lamps is a minimum, and in order to do this the rate of variation of life of a lamp with its efficiency, should be known. This variation would have to be given by the manufacturer.

To give this equation in the shape of a formula we will assume symbols to represent the various factors.

Let A = the number of watt hours required by a 16-candle power lamp. A ÷ 16 would represent the efficiency per candle power.

Let B = the life of the lamp at A ÷ 16 efficiency.

Let Y = the cost of a 16-candle power lamp.

Let X = the cost of a watt hour delivered at the lamp.

The value of A and B must be ascertained from the manufacturer.

Y is the price that has to be paid for the lamp.

To obtain the cost of a watt hour, or X, delivered at the lamp, the mean current of the station must be determined. As the wires and devices have been figured for a certain loss for maximum current, the energy in transmitting the mean current would bear the same ratio to the percentage, figured for the maximum load, as the mean current does to the maximum current. This amount of energy must be subtracted from the total energy developed and the remainder will give the amount of energy used in the lamps. The total operating expenses, less the cost of lamps, divided by the total watt hours delivered at the lamps, will give the cost of one watt hour.

The cost of operating a 16 candle power lamp for an hour would be the cost of a watt hour multiplied by the number of watts required by the 16 candle power lamp, or X × A.

The proportion of cost for replacing lamps would be the price of the lamps divided by the life, or Y ÷ B.

The most economical point to run the station would be when the sum of the renewals and the cost of the energy is a minimum or expressed in a formula, when (Y ÷ B) + (X × A) = a minimum.

To give an example of this we will assume conditions. Let cost of lamp = 50 cents, efficiency A ÷ 16 = 4 watts, or A = 64 watts; let X = $.00016, an average cost of electrical energy (being .8 of a cent for 50 watt hours), and the life of lamp 1,000 hours, and substituting these values in the formula we have $.50 ÷ 1,000 + $.00016 × 64 = ? or $.0005 + $.01024 = $.01074.

Another lamp costs 60 cents, its efficiency is 3 watts or A=48 watts. X=the same as in previous case, $.00016, and the life of lamp 300 hours, substituting these values in the formula, we have $.60÷300+$.00016×48=? or $.002+$.00768=$.00968.

The result shows that a lamp costing 60 cents and having a life of only 300 hours with three watts' efficiency makes the operating expenses of the station less than if the lamp was only 50 cents and had a life of 1,000 hours with 4 watts' efficiency; in fact, the 3-watt lamp is cheaper even though the 4-watt lamp cost but 1 cent and had a life of 10,000 hours, for the cost of the energy alone, for the 4-watt lamp is in excess of the sum of the cost of the lamp and energy in the case of the 3-watt lamp. The question is governed very much by the cost of the energy.

The incandescent lighting business has grown upon us so rapidly that we have been unable to keep up with the great advance, and the public has been suffered to remain in dense ignorance on one of the most important subjects of the present day. In fact, not only has the public been allowed to remain ignorant, but the great majority of central station men have had no opportunity whatever of gathering such data together that would enable them to fully comprehend the important part the incandescent lamp plays in their business, and wherein lay vital considerations.

The renewals have always been considered the bugbear of the central station, but the waste of energy has seldom received the slightest notice.

The success or failure of electric light central stations as dividend earning investments, is of the utmost moment to the agents, manufacturers of electric light apparatus and others who desire to promote the business. It is necessary for the success of those desiring to promote the electric light business that the electric light central stations make money. For the electric light central stations to be financially successful, those operating them should be convinced of the importance of using efficient lamps and of renewing them as soon as their efficiency materially depreciates.

The bugbear that exists in the minds of many central station men that it is the cost of renewal of lamps that represents the great expense, should be eradicated and the question of waste of energy so demonstrated that they cannot avoid seeing the advisability of efficiency rather than long life in the lamps they are using.

Briquettes.

A contributor to the *Colliery Guardian* renders the following interesting account of the growth of the foreign trade in coal briquettes:

Referring to the observations anent briquettes or patent fuel in recent articles on French colleries, and the fact that such fuel is much more largely used on the Continent than in our own country, we must admit that the cause is chiefly due to the less bountiful distribution of mineral wealth, the greater difficulty of working and consequently higher price of coal for a given calorific power. It is a trite saying that "plenty makes waste;" and the converse of this is also true. Continental coal masters are obliged, by the conditions under which they work, to practice economy and especially direct their attention to preventing waste. It is thus that slack is turned to the fullest account; and qualities not suitable for coke making are converted into briquettes.

Generally coal tar pitch is employed as an agglutinant, thus adding to the calorific effect of the product; but some briquettes are made in Belgium with about half the volume of clay, to judge by the quantity of ash and their slight heating power. Where, however, clay is obtainable on the spot without much expense in getting, loading and conveying to the machines, especially if a bank of clay, not wanted for bricks, has to be removed to make ground for the extension of works, such briquettes are not to be despised. Those referred to have all the appearance of being forced out in a continuous stream, cut off by wire to length, and then pressed with initials, raised on one side and sunk on the other, like pressed bricks. They have a clean, smooth surface, make dust only by chipping at the edges, and may therefore be thrown on to the fire without soiling the fingers. The great merit of these briquettes is that, though of slight calorific effect, they retain their heat for many hours, being thus very useful for keeping in a fire, ready to be "made up" with other fuel when occasion requires. It is a question whether a larger form of such briquettes might not be useful for banking up the furnaces of steam boilers and dampening down blast furnaces.

After the long and successful experience of the Alais blast furnaces, which are fired with two parts of briquettes to three of coke, it may be considered whether, instead of charging the fine dust of friable iron ore into the furnace, which is liable to be choked if the proportion be excessive, it would not be worth while to form the dust of such ore, with that of slack, into briquettes cemented by lime, which, being so intimately associated with the ore, would exert more influence as a flux, weight for weight, than the large pieces of limestone generally charged in. We shall shortly have something to say about the part played by special briquettes in the steel manufacture, a new practice which is calculated to revolutionize the trade.

With briquettes of such high calorific power as those produced in the Gard coal field, the advantage in their use by locomotives, especially ocean-going steamers, is obvious, on account of their packing into small compass. The advantage to the general consumer is a lower price for a given calorific effect, and that to the producer is the better utilization of what, in its raw state, is too frequently a waste substance, and at best an inferior sample.

The Eastern Railway Company of France makes its own briquettes from the dust produced by the "manutention," or handling and conveyance, of its coal and coke, and also—a practice which it was the first to adopt—from the fine cinders carried along by the blast of locomotives and deposited in the smoke box. The machine used is that of Durand and Marais, with modifications carried out, at the suggestion of the company's engineers, by the makers, MM. Th. Dupuy et Fils, of Paris, and on which the engineer-in-chief reported that the results were satisfactory, sufficient cohesion being obtained with the usual proportion of pitch. M. Gambaro, engineer in charge of the company's briquette works, reported that, with 10 per cent. of pitch, the cohesion of coal briquettes was from 56 to 57 per cent., and of those from the fire-box cinders as high as 83 per cent. Subsequently, Messrs. Dupuy started a briquette manufactory at Paris, for the double purpose of permitting the performance of the machines to be closely watched, so as to introduce the modifications and improvements dictated by actual practice, and of affording the opportunity to their customers of trying the machines with any given substance or mixture on the scale of actual working. The consequence is that the machine, well known and highly appreciated on the Continent, has been greatly improved (this development being now known as the Dupuy machine), and requires slight motive power in proportion to the production, while, at the same time, the quantity of pitch necessary to obtain a given cohesion is greatly reduced. For instance, a cohesion of 65 to 70 per cent. is now obtained with ground coal slack mixed with from 7 to 8 per cent. of pitch, while with coke dust the same high cohesion of 83 per cent. is obtained as with locomotive smoke box ashes. The pressure exerted by the size of machine which produces blocks of 6 kilogs. (13 lb.) weight is 52 tons, which give 100 kilogs. per square centimeter (or 1,422 lb. per square inch) of briquette surface; and, owing to the interposition of Bellville springs set at 80 per cent. of that amount, the pressure is elastic. In this manner uniformity of pressure is obtained equal to that given by a hydraulic regulator. The capacity of the compression chamber may be varied without stopping the machine, which is a useful quality, because it is almost impossible to secure absolute uniformity in any mixture, however great the care exercised, so that the machine may be used for coal or coke dust, or a mixture of the two. Moreover, as described by M. Edmond Peny, engineer at the Mariemont Colliery, bricks made by the same machine are, when well burnt, so hard and uniform that they may be used for underground work. Inasmuch as a uniform density is secured, and also a uniformity of stroke through the facilities for taking up wear in the compression parts, the product is uniform both in density and volume, and therefore also in weight, while briquettes of various shapes and sizes, more than one at a stroke, and also perforated briquettes for domestic use, may be produced.

The process is carried out as follows; The coal tar pitch, broken roughly, is placed in two pails of equal capacity, containing together sufficient for mixing with the desired quantity of ground slack. One pailful of pitch in pieces is thrown into the bottom of a truck, which then receives the given quantity of slack dust, and then the second pailful of pitch is thrown over it. The truck is tipped into a hopper in connection with an archimedean screw, which feeds the mixture up to a mill for reducing the whole to fine powder and completing the mixture. The latter is received on falling by a Jacob's ladder, which raises it to the incorporator, a hollow vertical cylinder with revolving shaft and arms, and provided with a pipe which introduces steam of 70-pound pressure for softening the pitch. Here the mixture is reduced to a plastic paste, which falls from a spout into the distributor of the pressing machine, being injected in the form of finished briquettes.

The same paste, and especially that made with anthracitous coal, may also be moulded under pressure into balls of various size, which have the advantage of possessing the largest possible surface for a given volume. The consequence is that combustion, especially when the balls are perforated with a hole in the direction of their diameter, is greatly favored, rendering this form of fuel particularly valuable when it is required to get up steam quickly, as in the case of a steam fire engine. In cases where a very high degree of compression simultaneously above and below the briquette is desirable, especially for conglomerating iron and manganese ore and the so-called "purple ore" for treatment in the blast furnace, as referred to above, an ingenious machine has been devised by Messrs. Dupuy. It consists of two beams, pivoted near their inner ends, and the outer ends of which are brought together by a right and left-handed screw, worked either by hand wheel or by belt from any source of power, and exerting a considerable pressure near the fulcra of the beams. The pressure is maintained for such a length of time as will suffice to weld powdered sugar into a solid block, one-third less than would be required if that pressure were exerted for an instant only, and therefore exercising a similar effect on the composition for forming ore briquettes.

In referring to the above and other machines used with success on the Continent, we have no intention of disparaging those of our own manufacturers. We are perfectly aware that there are excellent English machines in the market, and that the mechanical ingenuity of our engineers is fully able to meet any reasonable conditions required in a machine. Our object is rather to stimulate interest in the subject, and show the advantages of using a well-made briquette of low as well as of high calorific effect.

The Distribution of Electrical Energy.

At the last (April 7) ordinary meeting of the Institution of Civil Engineers (England), Mr. R. E. B. Crompton read a paper on the cost of the generation and distribution of electrical energy, of which the following is a summary:

Machinery for the supply and distribution of electrical energy came under two heads, namely, the generating plant, comprising boilers, steam dynamos and switching apparatus, and the distributing plant, consisting of a network of conductors, supplemented in some cases by accumulators, and in other cases by transforming apparatus to change energy from high-pressure to low-pressure.

Part I.—Cost of Generation.—With the high efficiency of 96 per cent. which was now attainable in dynamos, the cost of the electrical energy ought only to be a small fraction in excess of that of a corresponding amount of mechanical energy. The wide differences between the calculated amount and the figures attained in practice, were considered. The three items of cost, namely, material, labor, and up-keep, were influenced chiefly by the "load factor," the design and arrangement of the plant, and the local cost of material and labor.

The author had given the name of load factor to the relation which the actual output of any given plant bore to what would be its output if it were worked continuously at the full load. In order to compare the relative economy of fuel, water, or other material used in generating electrical energy, he had fixed on a consumption of 25 lb. of water and 2½ lb. of Welsh coal per unit generated as a standard which might be reached in the future, although nothing approaching those figures had yet been attained in practice.

He then proceeded to describe the electrical supply stations from which

the data for the paper had been obtained, namely, the Kensington and Knightsbridge Electric Lighting Company, and the St. James's and Pall Mall Electric Lighting Company. The load factor of these stations varied from the exceedingly low figure of 2.5 for the Kensington Station in the month of August to 41.5 on one occasion, which was the best load factor of the St. James's and Pall Mall Company's station, and showed how these varying load factors affected the cost of production. It was pointed out that a limited use of storage plant could reduce the consumption of fuel, etc., and shown by a diagram that the proportion of accumulators should be about 20 per cent., or one-fifth of the whole generating plant. The author recommended a return to the older type of internally fired boilers; the chief cause of the small evaporation, in low load factor stations, was the loss of heat incurred in getting up steam in several boilers for only short periods every evening. Several types of boilers which had been found to have special advantages were described, one important consideration being that in electrical light stations the space from front to back was frequently limited, so that a boiler which could be built up to a height of from 14 ft. to 16 ft. offered several advantages.

Distribution.—The cost of distributing electrical energy was made up of that of the up-keep of the distributing plant and of the percentage of the energy which was lost by the fall of pressure in the conductors. It followed that the merit of competing systems was inversely as the cost of generating the units so wasted, divided by the up-keep of the conductors. For instance, if in distributing 20,000 units to a given distance, system A wasted 1,000 units in a given time, the cost of up keep for the same time being £10, whereas system B wasted 3,000 units at a cost of up-keep of £3, B was slightly better than A, because $\frac{3000}{10} : \frac{1000}{3} :: 300$ to 333. It was difficult to apply the method of comparison to the systems now in use, as the cost of the up-keep was not yet known with sufficient accuracy. The author's opinion was that whenever underground mains consisted of continuously insulated cables, the sum required for up-keep would be not less than 4 per cent. of the original cost, and was not likely to exceed 7 per cent. When, however, the underground mains took the form of bare copper conductors with glass or porcelain insulators, the cost of up-keep might be as low as from 1 to 2 per cent. In this connection the distribution system of the Kensington and Knightsbridge Company was described, and reference was made to the systems of supply for St. James's and Pall Mall, Westminster, Notting Hill, and for the St. Pancras Vestry, also that in use at Birmingham.

The author had found difficulty in obtaining accurate accounts of the cost of distribution by the alternating transformer system, but all the published accounts had shown that the total net cost per unit was greatly in excess of that of the low-pressure system. The author had under his charge a plant of generating and distributing machinery on the alternating transformer system for the public lighting of Chelmsford, a small private demand existing in addition. In this case the machinery was worked for long periods at a high-load factor, so that the cost of generating was exceptionally low, and as the load in the transformers was perfectly regular, it had been possible to so proportion them as to be worked continuously at their maximum efficiency. A table showed that the load factors for this station for the months of August and December, 1890, and a twenty-four hours' load diagram, taken on January 20, 1891, was exhibited. The annual load factor was found to be 31.0, and the pounds of coal per unit generated, 8.88; the pounds of coal per unit delivered, 10.70, hence the efficiency reached 83 per cent. But this was an extremely favorable example, and an alternating transformer installation in a medium-sized private house in the Kensington district, tested by Professor Ayrton, was found to have a mean annual efficiency of only 53 per cent.

The remedy for this defect in the alternating system consisted in what had been called "banking" the transformers. This meant that a district to be supplied with electricity should be laid with a low-pressure network, in all respects similar to that provided for the direct low-pressure system; but in place of the feeders, and at the point where the feeder mains were connected to the network, a fireproof and incombustible chamber should be formed under the surface of the roadway. In this a number of transformers of graduated sizes were arranged, with the high-pressure mains connected to them, so that the transformers might be switched into action automatically as required—that was to say, during the hours of light load the smallest only would be in action, the others being automatically added as the demand increased.

Summarizing his experience, the author endeavored to show:

1. The actual cost of generating and distributing electrical energy on the scale at which it was now produced, and with the machinery that was already installed.

2. The direction in which improvements might be introduced to secure greater economy.

3. The important effect of a variable load factor, which might be almost entirely eliminated from the cost sheets of those who desired to employ electrical energy continuously.

4. That the losses on distribution in low-pressure supply were already so low that further improvement could not be expected.

5. That the existing systems of alternating supply would have to be greatly modified if they were to be used in residential neighborhoods having low load factors.

The Proposed McDonald Bill to Enable Cities and Towns of Massachusetts to Distribute Gas and Electricity.

The following is a resume of the text of the bill proposed by Mr. McDonald, of Middlesex, as a substitute for the adverse report on this subject submitted to the Massachusetts Legislature by the Committee on Manufactures. The bill contains 17 sections, the first three of which are given in full:

Sec. 1. Any city or town may, under the limitations of this act, purchase, lease, or establish and maintain within its limits one or more plants for the manufacture or distribution of gas or electricity for furnishing light for municipal use, or for the use of such of its inhabitants as may require and pay for the same as herein provided. Such plants may include suitable land, structures, easements, water privileges, stations, gasometers, engines, tools, machinery, pipes, conduits, poles, conductors, burners, lamps, and other appliances for making, generating, distributing, and using gas or electricity for lighting purposes.

Sec. 2. No city shall exercise the authority conferred in section one until a vote that it is expedient to exercise such authority shall have passed each branch of its City Council by a two-thirds vote and received the approval of the Mayor in each of two consecutive municipal years, and thereafter have been ratified by a majority of the voters present and voting thereon at an annual municipal election. When such a vote has failed to secure such ratification no similar vote shall be submitted for ratification until after the expiration of five years thereafter.

Sec. 3. No town shall exercise the authority conferred in section one until after a vote that it is expedient to exercise such authority shall have been passed by a vote of not less than two-thirds of the voters present and voting at each of two legal town meetings duly called for the purpose, of which meetings the second shall be held at an interval of not less than two nor more than thirteen months after the first. At such meetings such vote shall be taken by written or printed ballot, and by the use of the check list.

Plants purchased are to be paid for by the issue of 30-year 5 per cent. bonds, outside the debt limit, but the whole amount of bonds is not to exceed 2 per cent. of the total valuation of estates of the city or town. The price to be charged for gas or electricity to persons and corporations is to be fixed, and is not to be changed oftener than once in three months. "Any change shall take effect on the first day of a month, and the new price adopted shall, before the change shall take effect, be advertised in some newpaper published in the city or town where the plant is, if any is published therein. Such price shall not, except with the written consent of the Gas and Electric Light Commissioners, be fixed at less than cost, in which shall be included in addition to all operating expenses interest on the net investment in plant made by the city or town, less assessments collected under section six, at the rate paid upon the bonds above provided for, together with the requirements of the sinking fund established to meet such bonds, and also depreciation of the plant, to be reckoned at not less than five per cent. per annum of its cost, and losses; but any losses exceeding three per cent. of the investment in plant may be charged in different years at not more than such three per cent. per annum. Such price shall not be greater than shall allow above such cost a profit of eight per cent. per annum to the city or town upon its net investment." Section 12 is, in part, as follows:

"When any city or town shall decide as hereinbefore provided to establish a plant, and any person, firm or corporation shall at the time of the first vote required for such decision be engaged in the business of making, generating, or distributing gas or electricity for sale for lighting purposes in such city or town, such city or town shall, if such person, firm or corporation shall elect to sell, and shall comply with the provisions of this act, purchase of such person, firm or corporation, before establishing a public plant, such portion of his, their or its gas or electric plant and property suitable and used for such business in connection therewith as lies within the limits of such city or town. If in such city or town a single corporation owns or operates both a gas

plant and an electric plant, such purchase shall include both of such plants, but otherwise such city or town shall only be obliged to purchase the existing gas plant or plants if it has voted only to establish a gas plant, and shall only be obliged to purchase the existing electric plant or plants if it has only voted to establish an electric plant.

"If the main gas works, in the case of a gas plant, or the central lighting station, in the case of an electric light plant, lie within the limits of the city or town which has voted to establish a plant as aforesaid, such city or town shall purchase as herein provided the whole of such plant and property used in connection therewith, lying within its limits, and the price to be paid therefor shall be its fair market value for the purposes of its use, no portion of such plant to be estimated, however, at less than its fair market value for any other purpose, including as an element of value the earning capacity of such plant based upon the actual earnings being derived from such use at the time of the final vote of such city or town to establish a plant and also any locations or similar rights acquired from private persons in connection therewith, plus the damages suffered by the severance of any portion of such plant lying outside of the limits of such city or town and minus the amount of any mortgage or other incumbrance or lien to which the plant so purchased, or any part thereof, may be subject; such value shall be estimated without enhancement on account of future earning capacity or good will, or of exclusive privileges derived from rights in the public streets. When any capital has been paid in, in property instead of in cash, the valuation placed upon such property in estimating it as paid-in capital shall not be conclusive in estimating its value under the foregoing provisions, but may be disputed by a city or town, and if shown to have been excessive may be reduced by the authority fixing the price of the plant and property as hereinafter provided. If the main gas works or central lighting station of such a plant do not lie within the limits of the city or town which has voted as aforesaid, then such city or town shall only purchase as herein provided that portion of such plant and property which lies within its limits. No city or town shall be obligated by this section to buy any apparatus or appliances covered by letters patent of the United States or embodying a patentable invention unless a complete right to use the same and all other apparatus and appliances necessary for such use within the limits of such city or town to such extent as such city or town shall reasonably require such right shall be assigned or granted to such city or town at a cost as low as the cost of such right would be to the person, firm or corporation whose plant is purchased."

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. FREDERICK BREDEL informs us, and at his wish we make notice of the fact, that on account of the rapidity with which his Western business has grown, he has determined to locate himself permanently in the city of Milwaukee, Wisconsin. His headquarters are to be at 118 Farwell avenue. In the meantime his business east of the Alleghany Mountains will be in charge of Mr. Julius Buss, whose offices are at No. 22 Beaver street, this city.

MR. JAMES R. SMEDBERG has removed from Hamilton, Ohio, to Peoria, Ills., where he has opened offices, and announces his willingness to take up contracts for the enlargement or repair of old works, the building of new ones, etc. He is located at No. 213 North Jefferson avenue.

MENTIONING the above brings to mind the fact that Mr. Smedberg has just completed the plans and specifications of an exhauster house for the Peoria Gas Light and Coke Company. The building will be 47 ft. 4 in. by 42 ft. 3 in. outside, with a brick chimney 60 feet high. The apparatus is as follows: Two compromise boilers, 48 in. diameter by 16 ft. long, with 10 six in. flues, mud drums and "Eclipse" manheads; a Stillwell heater; a No. 7 Root's exhauster, with engine on same bedplate; and a 16-in. Connelly street governor. There is an overhead water tank, 12 ft. diameter by 7 ft. deep; and the pumps necessary for a circulating scrubber flow, for water supply, for boiler feed, and for delivering coal tar. The connections are 16 in. The brick work is laid on cement mortar, and the whole construction is of the best and most durable character. The cost will be between $11,000 and $12,000.

THE Berlin Iron Bridge Company, of East Berlin, Conn., met with a temporary setback in their building operations on their extension to the factories at East Berlin. A cyclone that swept over that section on April 23 demolished about 200 feet of the iron frame which had been set up, but it should not be inferred that the ordinary business of the Company was in any manner retarded thereby.

IN the United States Circuit Court, Phila., Pa., no appearance for defendant having been made, a decree was entered for the complainants in the suit of the Electric Gas Lighting Company and Abraham L. Bogart against Horace A. Pinkham, enjoining the latter perpetually from infringing on the complainants' patented improvement for lighting gas by electricity. The case was referred to Francis T. Chambers, Esq., to assess the damages sustained.

AT a special election, held some days ago, the voters of Le Mars, Ia., decided against bonding the city in $20,000 for the purpose of installing an electric lighting plant to be operated on municipal account.

THE works of the Belleville (Ont.) Gas and Electric Light Company have been leased, for the term of 10 years, by Mr. Pearson, of the Consumers Gas Company, of Toronto. We understand that Mr. Pearson agrees to pay 6 per cent. per annum on the Company's stock ($80,000) and 6½ per cent. on a mortgage of $38,000, the Company to pay all taxes.

"THE annual meeting of the Derby Gas Company, of Birmingham, Conn., was held at the appointed time, and the shareholders had small reason for complaint over the showing made for the twelvemonth. Prosperity was their portion, and a steadily increasing business is that which immediately confronts them. The annual elections resulted in the following choices: President, Colonel William B. Wooster; Secretary and Treasurer, Charles H. Nettleton; Directors, William B. Wooster, William E. Downs, Thomas Wallace, P. M. Bassett, Charles Nettleton, F. E. Hoadley, A. S. Terry, C. E. Clark and Charles H. Nettleton.—HADDAM."

THERE is no likelihood that the Illinois Legislature will pass the Wilson bill authorizing cities, incorporated towns and villages to furnish their inhabitants with gas and electric lights, both for public and private account.

SOLICITOR ANDERSON has been instructed by the Akron (O.) City Council to enjoin the Fuel Gas Company from tearing up the pavements on Mill and Forge streets, through which it proposed to put its pipes. The city's action is based on the ground that the Company has forfeited its rights in the premises because of the imperfect manner in which other pavements disturbed by it were relaid.

AT the annual meeting of the Ottawa (Can.) Gas Company the following officers were chosen: Managing Director, Hon. Francis Clemow; Secretary and Treasurer, Alexander Spittal; Directors, Allan Gilmour, James MacLaren, Robert Blackburn, Thomas Patterson, S. Howell, T. C. Kelfer and Francis Clemow.

JACOB STITT, of North Topeka, Kansas, was recently awarded $400 damages against the Brush Electric Light and Power Company, because of an injury to his sight, received through contact with a poorly insulated wire. Stitt, who is a groceryman, was gathering up some potatoes that had been scattered over the floor, and while in a stooping position came in contact with an iron casing of a door, the casing being heavily charged with a current conveyed to it from an imperfect light wire owned by the Company. The case was tried before a jury in the Shawnee Circuit Court.

MR. J. W. AVERILL has been appointed Superintendent of the Biddeford (Me.) Gas Company.

THE proprietors of the Fort Madison (Ia.) Gas Company have determined to put the plant in good working order, which will involve an expenditure of several thousand dollars. The rates have also been greatly decreased, for, as we understand it, the Company will sell gas for lighting purposes at $1.25 per 1,000—the fuel gas rate to be not over $1, with a possibility that it may be put at 90 cents.

WE are indebted to a Terre Haute (Ind.) correspondent for the following: "Judge Kirkpatrick, of the Howard Circuit Court, has rendered an opinion in which he holds that the McHugh natural gas law is unconstitutional. This is the law which forbids the use of artificial means to increase the flow of natural gas from wells or through pipes, and the real object of the measure was to prevent the draining of the Indiana gas field to supply Chicago and other large cities in other States. A law passed two years ago directly prohibiting the piping of gas outside the State was declared invalid by the Supreme Court. The effort in the present law was to create a statute which would be constitutional and yet serve the same purpose as that intended by the law of two years ago. Judge Kirkpatrick holds that the Legislature cannot regulate inter-State

commerce in the manner attempted. The statute was drawn up by W. P. Fishback and Judge R. N. Lamb, of Indianapolis, and Mr. Fishback, in speaking of the Kirkpatrick decision, said: 'We believed when we drew up the law that we could defend it against all attacks, and I yet think the Supreme Court will uphold it. There are two grounds for the passage of this law. One is that with artificial pressure the pipes are likely to burst. They are laid along the public highways and near houses and explosions might be very disastrous. The other reason for the law is that the pumping of gas from wells quickly destroys them. By this means some wealthy Company, reaching out its tentacles in every direction, might, in a short time, ruin the gas wells in a large area. Mark, this would not simply injure the Company owning those particular wells, but it would injure all other wells near them and would work great damage to the entire community. This law is simply to protect the rights of the many against the few.'"

THE opinion of Judge Edwards, in the case of Hargis & Easton against the Louisville Gas Company for a contingent fee of $25,000, has been filed and it is in favor of defendant. In the course of his remarks, which are quite lengthy, Judge Edwards says: "It appears that the agreed certain fee of $500 has been paid and plaintiffs prosecute this action to recover the agreed contingent fee of $25,000. It further appears that plaintiff urged that application be made to one of the Justices of said Supreme Court for a *supersedeas*, and that although the original attorneys of the Louisville Gas Company thought it was too late for the *supersedeas* to be of any service, one of them, in conjunction with plaintiffs, did make the application, plaintiffs doing most of the work in doing so. The application for a *supersedeas* failed, but it resulted in receiving a trial and a decision of the case in the Supreme Court, on December 7, 1885, reversing the judgment of the Court of Appeals. If no such application had been made it is reasonably certain that a trial and decision of the case would not have been reached prior to 1888. The mandate from the Supreme Court to the Court of Appeals issued Feb. 1, 1886, and pursuant to that mandate the Court of Appeals directed this Court to set aside the order formerly entered upon its mandate, and to reinstate the judgment dismissing the petition of the Citizens Gas Light Company, and this was done Feb. 10, 1886. It appears that prior to Oct. 1, 1885, plaintiffs urged the defendant to file a petition and to apply to a State Court for an injunction restraining the Citizens Gas Light Company from making or vending gas in said city, and at the request of defendant plaintiffs prepared such a petition, and defendant, after taking the advice of its original attorneys, decided that it was not to the interest of defendant to file an action of that kind, for reasons shown in the correspondence between it and plaintiffs on that subject. Opinion: Are plaintiffs entitled to recover the contingent fee? If by any action plaintiffs instituted or aided in instituting a course whereby the Citizens Gas Light Company was excluded from making and vending gas, from Oct. 1, 1885, till Dec. 31, 1888, plaintiffs should succeed. It is clear from the record that no such result was actually secured, and unless such failure was caused by the misconduct of defendant, plaintiffs cannot recover." The opinion states that the contract did not mean to say that the Company "should be excluded from making or vending gas unlawfully." The language is, "shall be excluded." The purpose was to stop the manufacture of gas by the Citizens Gas Light Company. This is manifest from the correspondence. The construction cannot be sustained that it was only necessary to obtain a decree some time before Dec. 31, 1888, forbidding the Citizens Gas Light Company, when the language of the contract and all the circumstances are fully considered. The evident purpose of President Baxter was to cut off competition in the making of gas, and the record shows that that result was expected. The Judge holds that the injunction proceedings were unnecessary, as an injunction was already in force. Plaintiffs cannot recover on the *quantum meruit*, for the contract fixes their rights, and no ground is laid for such recovery. If the plaintiffs performed their contract they should recover, "the general rule being that where there has been a special agreement the action must be founded upon it, and there can be no recovery upon a *quantum meruit*." The petitition was dismissed and an appeal is asked for.

THE Guild of Gas Managers gave a complimentary dinner to Mr. Edward C. Jones, at Young's Hotel, Boston, on Wednesday last. This action was taken to signify their appreciation of his abilities as an Engineer, and as an acknowledgement and recognition of his honorable and straightforward career during his many active years in the gas business in New England. Covers were laid for 40 guests, and President Leach, of the Guild, did the honors with the delicacy of a Vanderpool and with the vigor of a Stedman. The hour was fixed for 1 P.M., and the proceedings were flawless. The sentiment of the speeches was all one way—sorrow that Mr. Jones was leaving the East, satisfaction that his journey Westward was to end in a higher position, if increased responsibility and greater recompense are to be taken as proofs.

THE proprietors of the Saratoga (N. Y.) Gas and Electric Light Company have purchased the local incandescent electric lighting plant formerly operated by the North American Construction Company, and will hereafter operate the same. Notice has been given that all existing lighting contracts are to be cancelled, and the rates at which the service is to be carried on will be made known by the 5th inst. The Gas Company also announces a reduction in the gas rate to $2 per 1,000 cubic feet.

SOME days ago President Reemelin, of the Cincinnati Board of Public Improvements, secured the passage of the following resolution:

"*Resolved*, That the Solicitor be requested to prepare the necessary ordinance to provide for the purchase by the city of the gas works of the Cincinnati Gas Light and Coke Company, under its right in the Conover contract."

Mr. Ellison was the only member of the Board who voted against the resolution, and President Reemelin says this is the first move in the campaign that is to witness the discomfiture of General Hickenlooper. Sorrowfully remembering the fact that Herr von Moltke is dead, we were not prepared to hear just yet that a fitting one to sustain his mantle had been found, nor can we restrain our amazement at the bare possibility that the hero is resident in and a public official of Cincinnati. In the meantime it might be well that President (or Field Marshal) Reemelin should recollect that von Moltke had his bad days—especially at the outset of his wonderful military career—and that he did not fly too high at the start. *Ergo*, would it not be in order that President R. should open his warfare, say, for instance, on the dirty streets of Cincinnati, rather than by training his guns on the Cincinnati Gas Company. There might be more mud than glory in the street campaign, but victories over the mud of a city are valuable. They conduce to the peace of the dwellers therein, and is not that the end of all honorable warfare?

WHEN the Reemelin resolution became public property, of course the newspaper men pointed their pens at General Hickenlooper, and the General responded something after this fashion when appealed to for his views on the willingness of his Company to abide by the terms of the "Conover contract": "I am quite willing to sell out at any time. As the stock is worth $207 per share, this makes our plant worth $14,490,000—quite a handsome debt for the city to burden itself with." When asked "Would municipal gas management be a success?" the General replied: "Not strikingly so. At least the reports from three large cities where it has been tried seems not to prove it. Philadelphia is one of the cities I refer to, and the people there pay $1.50 per 1,000 cubic feet for gas, while we furnish it at $1.15 and besides pay 10 cents per 1,000 into the city treasury. The loss of this tax alone would be seriously felt. When the time comes, however, and a serious attempt is made to purchase the plant, I will give the city some statistics that will prove interesting reading; but, as I say, I am willing to step down and out to-morrow, if the city says so."

THE authorities at Franklin, Pa, have awarded to the Edison General Electric Light Company, of Pittsburgh, Pa., the contract for furnishing an electric lighting plant to be operated on municipal account. The specifications call for a plant to maintain 50 arcs of 2,000-candle power, each and 750 incandescents of 16-candle power each. The plant is to be in operation by July 1st.

ELSEWHERE we note a damage award made to a man named Stitt, of North Topeka, who secured $400 from the Brush Electric Light and Power Company because of injuries received by him from a live wire. A curious sequel to the case is afforded in a suit brought against the Company by one Grosch, who was assisting Stitt at the time the latter was "shocked." Grosch, on going to Stitt's relief, was also "shocked," but Grosch asks the Company to pay him $10,000.

THE complete executive staff of the reorganized Medina (N. Y.) Gas and Electric Light Company is as follows: President, C. T. Linny; Vice-President, J. T. Moffat; Secretary, C. T. Moffat; Treasurer, H. C. Hotchkins; General Superintendent, W. R. Curry; Directors, M. A. Clark, C. T. Linny, W. R. Curry, J. T. Moffat, C. T. Moffat, H. C. Hotchkins.

THE following awards have been made by the Gas Commission of New York city for the public lighting by gas of the city for the term from May 1st to December 31st, 1891. This action is taken to enable the mak-

ing of contracts in the future from the first day of each year, instead of the old practice of beginning these contracts with May 1st. The rates are identical with those made under the last contract:

Company.	No. Lamps.	Rate per Lamp for 8 Months
Consolidated	15,492	$11.666
Standard	2,171	8.696
Equitable	3,665	8.000
Mutual	216	11.666
Central	2,500	18.000
Northern	2,230	18.640
Yonkers	557	18.640

Other contracts for public lighting are:

Company.	No. Lamps.	Rate per Lamp per Night.
Brush Electric Light	273	40 & 45 cts.
United States	290	40 "
East River	240	40 "
Mt. Morris	132	40 "
Harlem	176	40 & 50 "
North New York	108	45 "

DIRECTOR OF PUBLIC WORKS WINDRIM has sustained Chief Engineer Park in the latter's treatment of the stokers at the Point Breeze station of the Philadelphia gas works. The Chief reported that the demands of the men were extravagant, and that they had been in no sense overworked.

THE Common Council of Milwaukee, Wis., has voted to indefinitely postpone consideration of the bill known as the fuel gas ordinance. This practically puts an end to the scheme, at least in its old shape.

THE new works of the Hagerstown (Md.) Gas Company will enable the Company to operate under far more favorable conditions than those at present existing at the old site, and the contracts for the new apparatus are virtually agreed to.

THE town of Union Hill, N. J., having experimented sufficiently with 32-candle power electric incandescent lamps as street lighting agents, has voted the same a complete failure. The residents declare that the incandescents do not give as good results as could be obtained from kerosene oil lamps.

THE new issue of stock ($100,000) in the Consumers' Gas Company, of Toronto, was disposed of at auction last month in the local salesroom of Messrs. Oliver, Coate & Co. A large attendance of capitalists was present, and the bidding was spirited. The shares were offered in lots of 10, and the average price received was 168½. The maximum price (on 30 shares) was 168¾, the minimum (also 30 shares) being 167. This shows which lighting security in Toronto enjoys the confidence of the investing public.

IN 1890 the Providence (R. I.) Gas Company's sendout amounted to 475,425,000 cubic feet. The total main system covers 175 miles, and the rate at which the gas was sold was $1.30 per 1,000.

SOME time ago Mr. James A. Renshaw, through Attorney Wynne Rogers, instituted suit in the Civil District Court against the Louisiana Electric Light Company, praying for the forfeiture of the lighting contract of the defendant with the city of New Orleans, and for an injunction restraining payment of the bills submitted by the Company. Mr. Renshaw alleges that he is a taxpayer and as such has an interest in the assets and property and improvements of the city. He shows that the City Council on March 26, 1887, adopted a motion directing the Comptroller to advertise during 30 days for bids for lighting with electricity the First, Second, Third and Fourth Districts of the city for five years. The Louisiana Electric Light Company secured the contract without competition because the Southwestern Brush Electric Light Company (another Company) formed a combination or pool whereby the Brush Company, for keeping out of the bidding, was to have the lighting of the parks and markets. By reason of this combination the city was made to pay at least 5½ cents per lamp more per light per night, a loss to the city of nearly $20,000 a year and aggregating for the five years of the contract not far from $100,000. The petitioner shows that the specifications for lighting distinctly state that no bid shall be considered from anyone who has entered into a combination prior to the time of bidding, whereby the city shall have to pay more for lighting than if no such combination existed. That should the contractor enter into such an agreement then, *ipso facto*, the contract shall be forfeited and all claims he may have upon the city up to the time of forfeiture shall revert to the city. Mr. Renshaw represents that the public order committee of the City Council found that the pool was formed, but nevertheless sent a majority report to the Council that the charter of the Louisiana Electric Light Company should not be declared forfeited nor its claims forfeited. That the Council declines to recognize the forfeiture of said contract, and recognizes the claim of the Company against the city for $11,637.73 for March lighting, and passed an order, April 14, appropriating that sum for the Company. Hence the prayer stated at the outset.

THE Vapor Street Light Company, of Canton, O., has instituted suit against the Standard Lighting Company, of Cleveland, O., basing the same on the claim that defendant has been infringing a patent for vapor burners controlled by plaintiff through purchase of rights from Martin L. Ballard and others. The court is asked to enjoin defendants perpetually from making or using vapor burners of the sort mentioned.

THE postponed annual meeting of the St. Paul (Minn.) Gas Light Company was brought off on April 21st, with the following result: Henry Villard was chosen President, to succeed the late General H. H. Sibley; Crawford Livingston, Vice-President and General Manager; B. F. Ellison, Secretary and Treasurer, to succeed A. B. Sibley and Morgan Brooks, formerly Secretary and Treasurer, respectively. Messrs. Henry Villard, T. F. Oakes and Crawford Livingston were chosen Directors.

JUDGE VALLIANT has issued an injunction decree in the case of the Laclede Power Company vs. the Laclede Gas Light Company, of St. Louis, restraining the latter Company from shutting off a supply of power to the former Company for 30 days, conditioned upon the plaintiff executing a bond in the sum of $5,000, and also to pay for the power used. In passing upon the matter Judge Valliant stated that, viewing the contract between the two Companies as an agreement on the part of defendant to furnish power, it was clear that the Court could not by the single process of injunction afford the relief prayed; it could only do so by compelling the defendant to continue for the period of five years to specifically perform its contract. He doubted very much if the petition made out a case in which a court of equity should interfere to control the parties in the further execution of their contract, as there were no questions involved which could not be reached by a court of law, with the exception, perhaps, of the injury to result from the sudden cutting off of plaintiff's supply and stoppage of its business. To that extent the Court might interfere; because, whether the defendant has a right to end the contract or not, it had no right to do so in such an unreasonable manner as to inflict unnecessary injury on the plaintiff. He would not decide whether the defendant has a right to supply power for similar purposes to other parties, or whether the contract is in any respect impaired. Those were questions that the parties must determine for themselves in a court of law. The only thing he would decide was, that even if the defendant has the right to end the contract, it has no right to exercise the control in the "unreasonable way threatened," and shut off the plaintiff's supply of power at once.

WE are sorry at not being able to give the full particulars in this case, which has aroused much interest in St. Louis, but the moral to be drawn from it is that the whims of great men should never be put forward by great men as a justification for their existence. Others would like to live, and he who can wait, either in the matter of forming an opinion, or in granting to another time wherein to find his error, is usually pretty well liked by his contemporaries.

Utilization of Atmospheric Oxygen.

The last new process for separating oxygen from the atmosphere by means of calcium plumbate has been further simplified, as the following summary of a paper by G. Kassner, which appears in the *Journal of the Chemical Society*, will show: The present paper is a continuation of a previous communication, in which the author described a new process for the utilization of atmospheric oxygen and the compounds on which the process is based. With regard to the preparation of the calcium plumbate, further investigations have shown that, instead of heating two equivalents of calcium carbonate and one of lead oxide, it is preferable to use a slight excess of the former, say about 5 per cent. In this way a spongy product is obtained, which admits of the conversion of nearly the whole of the lead oxide into plumbate. It is more advantageous to employ limestone instead of whiting, and it has also been found unnecessary to use mechanical contrivances for keeping the mixture in the form of a powder during the heating operation. This may be effected in an ordinary or reverberatory furnace supplied with a good current of atmospheric oxygen. For the production of oxygen on a large scale, the author now recommends heating the calcium plumbate in an ordinary furnace in the presence of carbonic anhydride, when oxygen is freely given off, according to the following equation: $Ca_2PbO_4 + 2CO_2 = 2CaCO_3 + PbO + O$. It will thus be seen that, by this process, unlimited quantities of oxygen may be obtained from one and the same material. The author considers his process superior to the methods of Brin and Boussingault for the following reasons: The formation of calcium plumbate is effected in the course of a few minutes, its decomposition by means of carbonic anhydride is complete, whilst the working expenses, cost of plant, and the value of material are extremely small.

The Market for Gas Securities.

Consolidated gas maintains its strength, and a trifle more, the opening figures to-day (Friday) being at 99½ to 100. Rumor again has it that the dividend rate is to be increased to 6 per cent., but Irving Place manages to hold its counsels pretty well within itself. We believe there is some foundation in fact for the intimated advance, which cannot and ought not, in justice to the shareholders, be much longer deferred. Mutual shows no change, and Equitable is dull and strong.

Over in Brooklyn the situation is not altered much, despite the possible change in the gas rate to $1.25, under the State law providing that in cities holding a population of 800,000, no higher rate for gas than that specified shall be charged. The Brooklyn Companies will insist that the law does not apply to them, therefore they will make out the bills on the $1.50 basis, which will precipitate the issue. Likely an injunction will be obtained, restraining the authorities from enforcing their view of the case until the court of last resort shall have determined what is to be. Chicago gas keeps just outside the half-par mark, and it is certain to go higher. Bay State is fairly steady, and holders of Rhode Island shares are to be congratulated on the failure of the Columbian Land Company's attacks on their properties. Consumers, of Toronto, is very much sought after, the new issue of $100,000 having brought at auction an average of $168½ per share.

Sold at auction: 300 Consolidated, city, at 98⅛; 10, same, at 99½; 15 shares Standard preferred, at 87; 10, Citizens, Brooklyn, at 85; 90 shares Brooklyn, at 114½.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

May 4.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	99½	100
Central	500,000	50	90	100
" Scrip	220,000	—	95	100
Equitable	4,000,000	100	116	119
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	119	121
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	—	48
Preferred	5,000,000	100	—	90
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	114	116
Citizens	1,200,000	20	88	90
" S. F. Bonds	320,000	1000	100	103
Fulton Municipal	3,000,000	100	130	131
" Bonds	300,000		100	105
Peoples	1,000,000	10	90	91
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	103	105
" Bonds (5's)	70,000	—	—	—
Nassau	1,000,000	25	138	—
" Ctfs	700,000	1000	100	102
Williamsburgh	1,000,000	50	130	—
" Bonds	1,000,000	—	108	112
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	—	87¼
2d " " "	3,000,000	1000	74½	76
Bay State Gas Co.—				
Stock	5,000,000	50	64	64½
Income Bonds	2,000,000	1000	95½	—
Buffalo Mutual, N. Y.	750,000	100	105	110
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds	45,000	—	—	—
Chicago Gas Company	25,000,000	100	51	51¼
Chicago Gas Light & Coke Co.—				
G't'd Gold Bonds	7,650,000	100	87	88½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	98
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	100
2d "	2,500,000	1000	94	98½
Consumers Gas Light Co., Jersey City	2,000,000	100	12	15
Bonds	600,000	1000	70	75
Cincinnati G. & C. Co.	6,500,000	100	207	209
Consumers Toronto	1,000,000	50	169	172
Central, S. F., Cal			92	100
Capital, Sacramento, Cal			58	
Consolidated, Balt	11,000,000	100	48¼	48½
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	110
Bonds	250,000		—	—
East River Gas Co., Long Island City	1,000,000	100	100	105
Bonds	500,000	100	100	102

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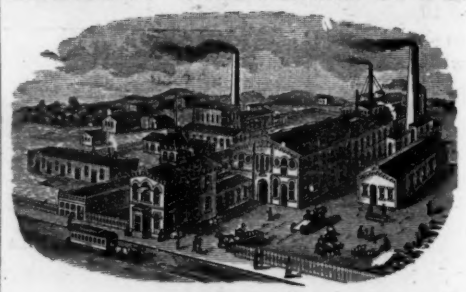

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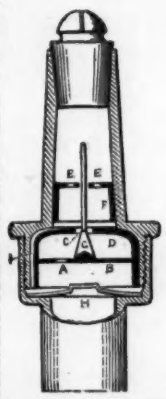

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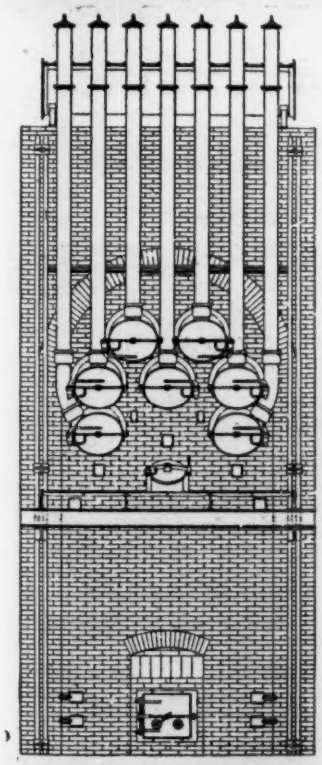

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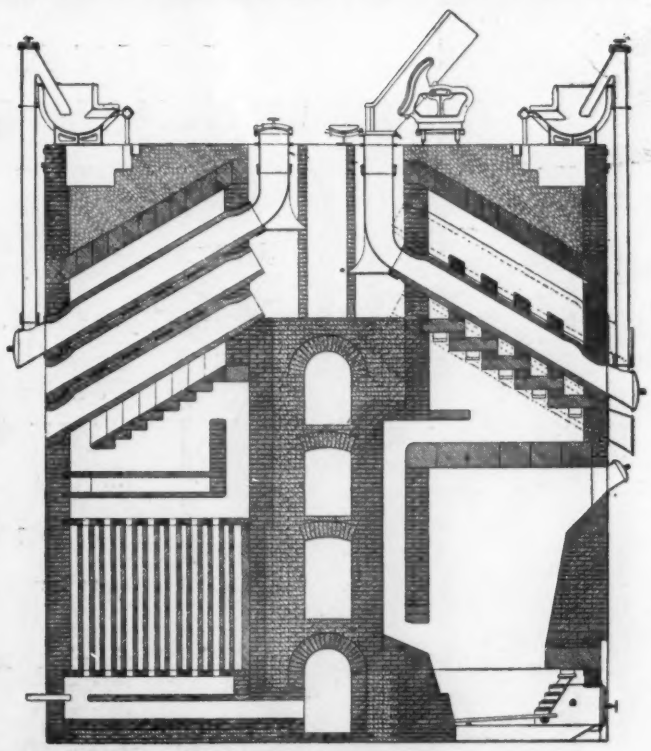

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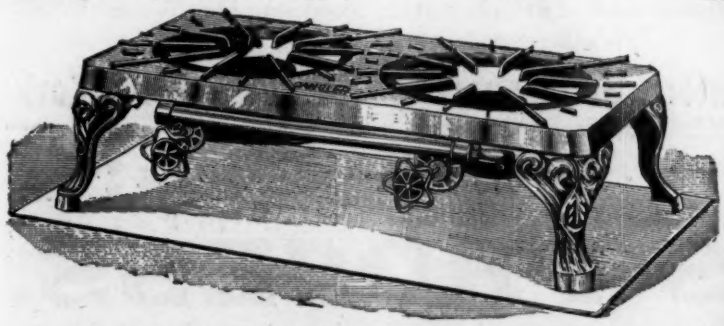

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Our system is such that we can furnish plants that will carburet 50,000 cubic feet in 24 hours, or three or four million feet in the same length of time. *One* of our large benches or plants would be capable of generating 100,000 cubic feet of gas in 24 hours, which would raise the candle power on 2,000,000 feet (taking as a standard coal gas at 15 candles) 3 candles on the 2,000,000 feet, enabling the works to deliver to consumers an 18 candle gas; or, enlarging our plant, the candle power may be increased as desired, at the same cost per candle power, less interest on plant.

This is much less per candle power than it can be furnished by the use of cannel coal or by vaporizing naphtha. With our process we improve the whole output in color—viz., whiten the flame with the oxygen, as well as furnishing a *thoroughly fixed* gas, and no possible danger of separation as there is with vapor. Correspondence solicited.

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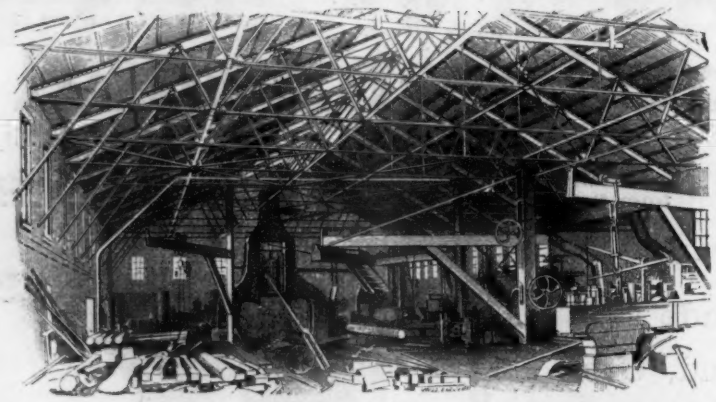

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The above illustration gives an interior view of an iron building designed and built by us for the Eastern Forge Co., at Portland, Me. The illustration is taken from a photograph, showing the jib cranes, steam hammer, and the general construction of the building, which is 70 ft. in width by 180 ft. in length. The building is built entirely of iron—iron sides, iron roof, covered with corrugated iron—and is absolutely fireproof. For Forge Shops, Rolling Mills, and that class of buildings this plan particularly commends itself.

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"Standard" Washer-Scrubber.

Extracts the Whole of the Ammonia and a Large Percentage of the Sulphureted Hydrogen and Carbonic Acid.

MINIMUM WEIGHT IN MOTION • MINIMUM DRIVING POWER • MINIMUM BACK PRESSURE • MINIMUM WEAR AND TEAR • WITH MAXIMUM RESULTS.

The "New" Washer-Scrubber, with Wooden "Bundles," has been for many months in successful operation at the London Gas Light and Coke Company's station at Beckton, and at many other European Gas Works. The "Bundles" can be supplied to "Standard" Washer-Scrubbers already in use.

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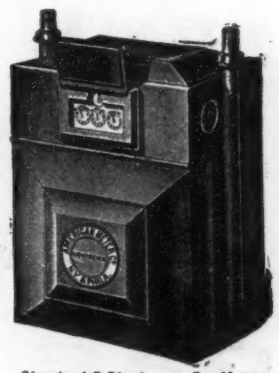

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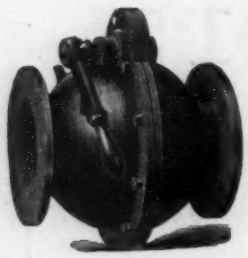

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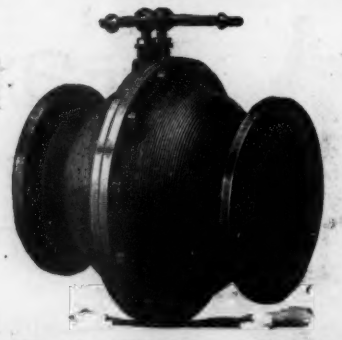

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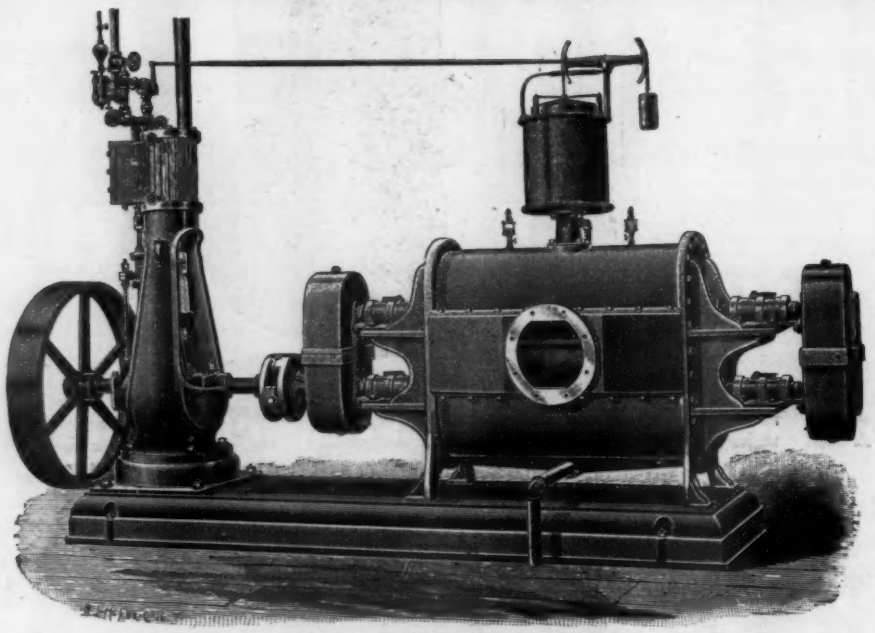

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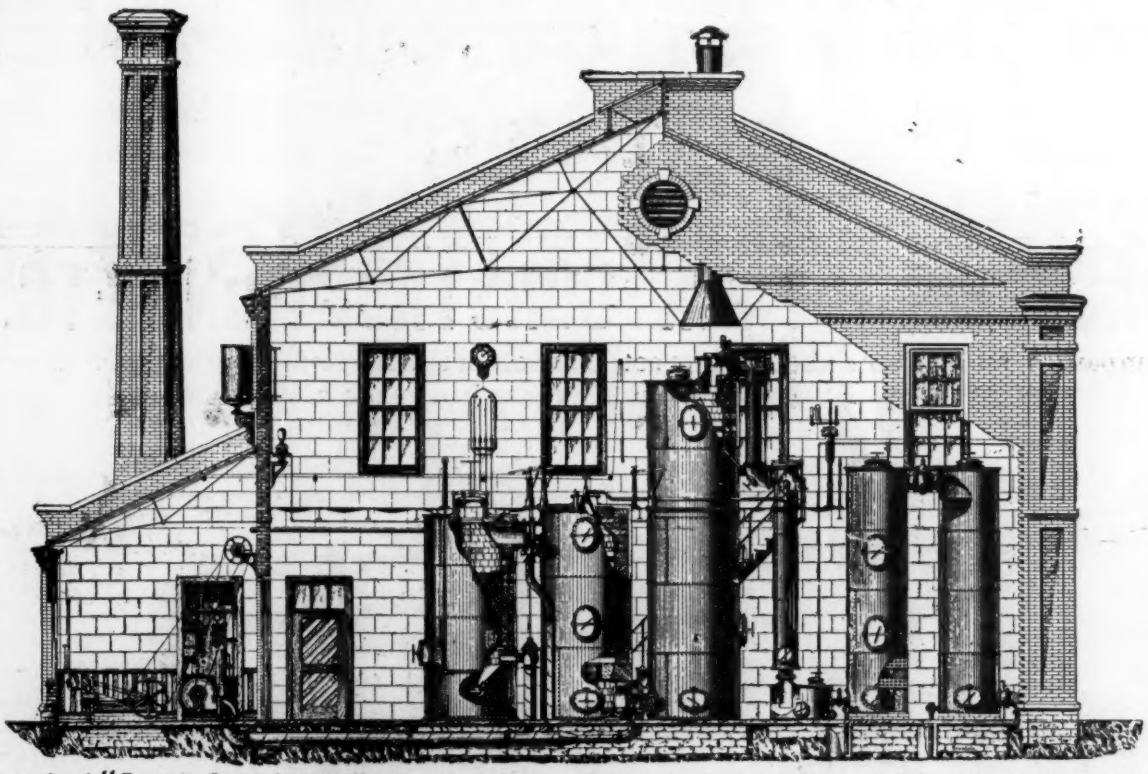

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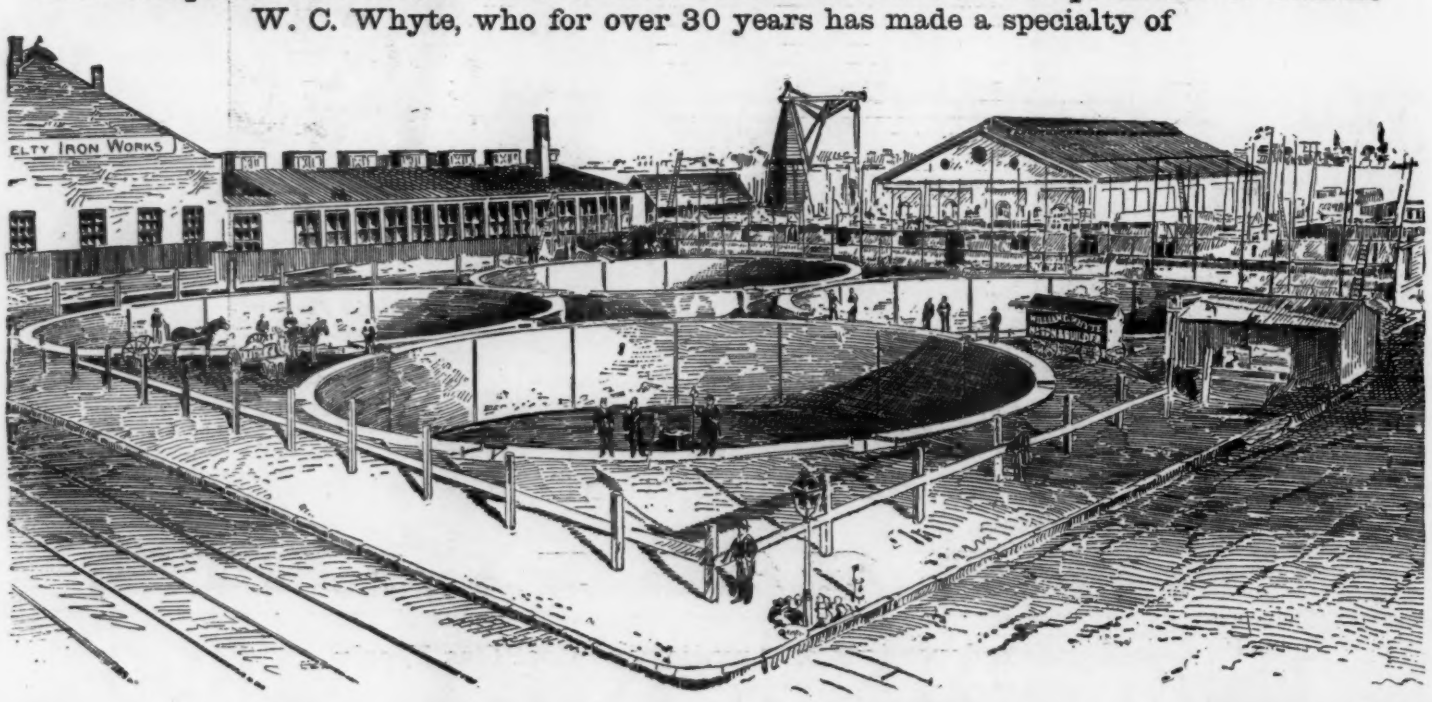

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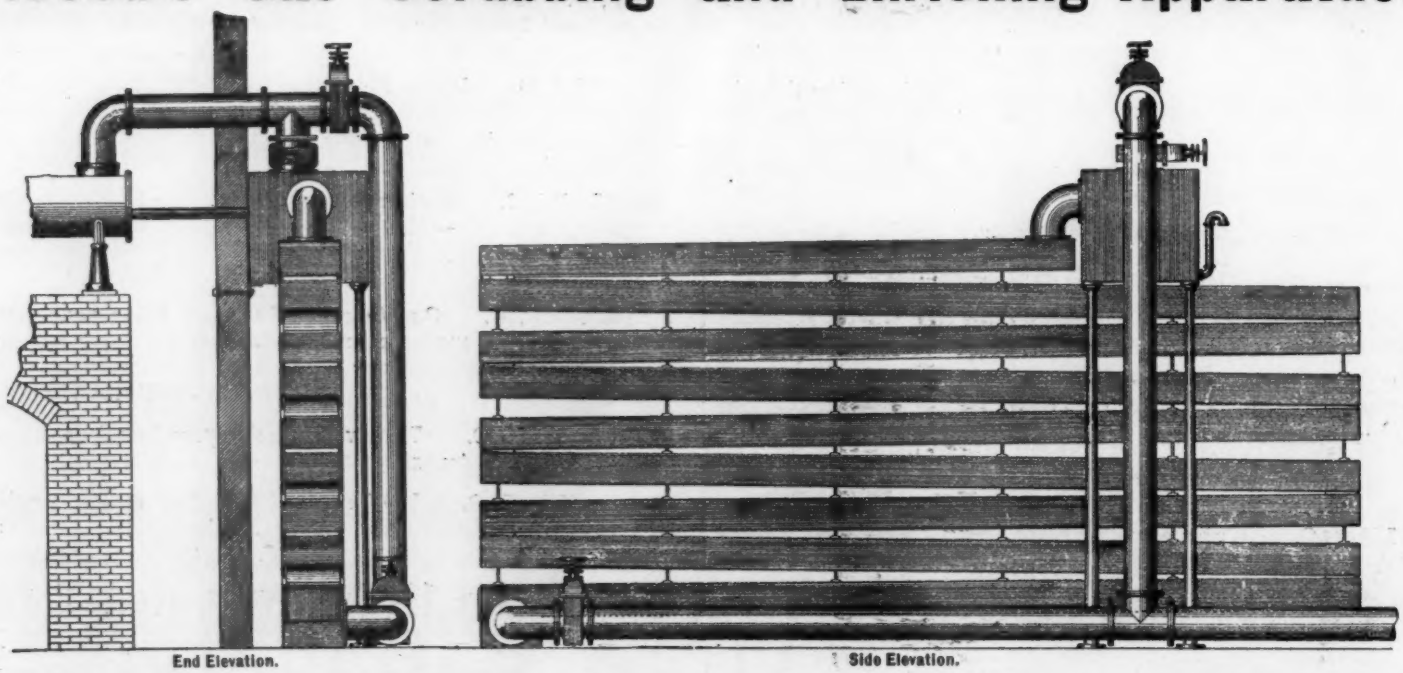

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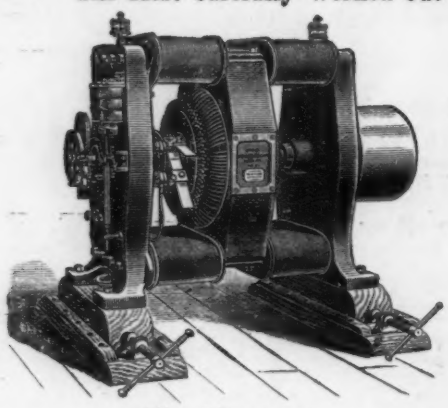

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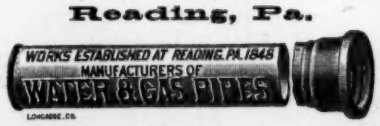

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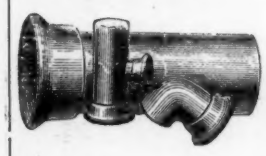

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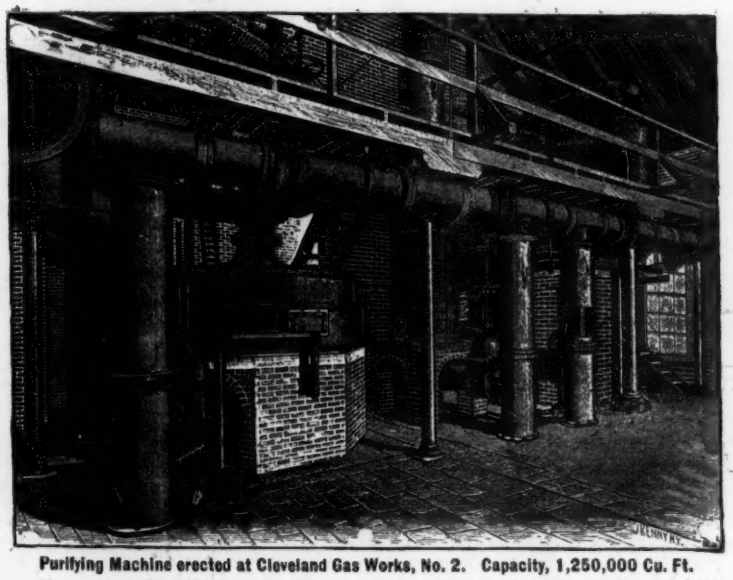

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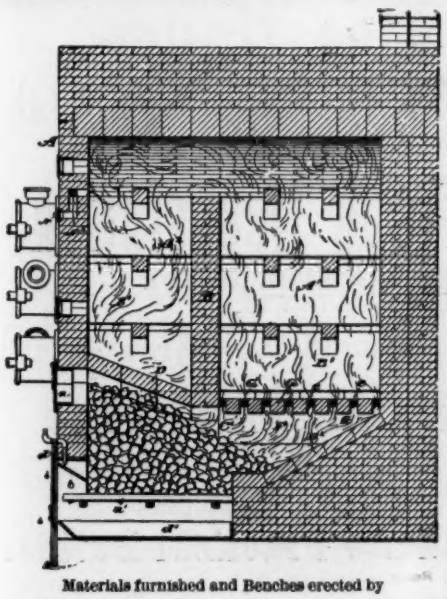

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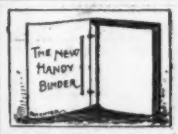

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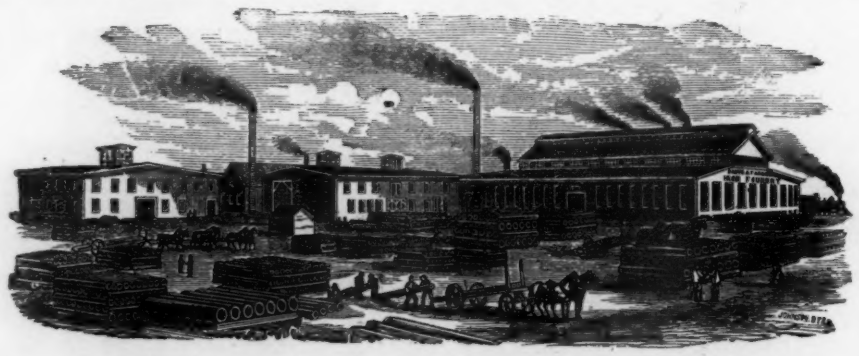

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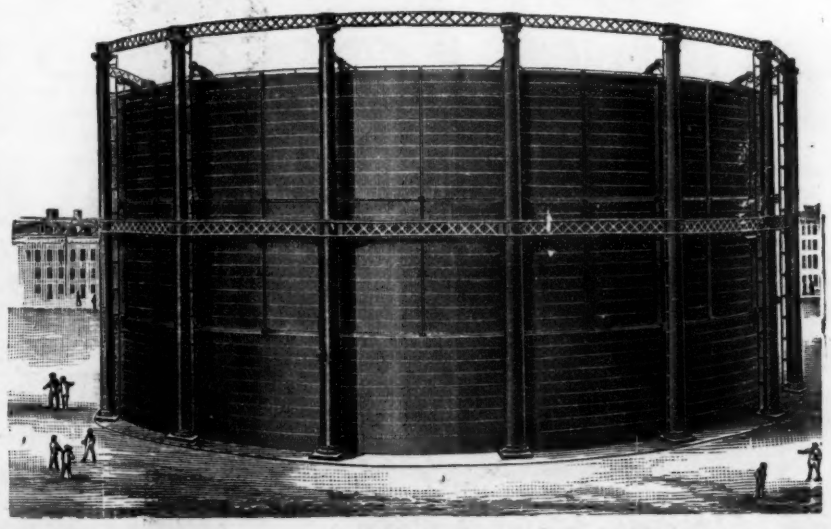

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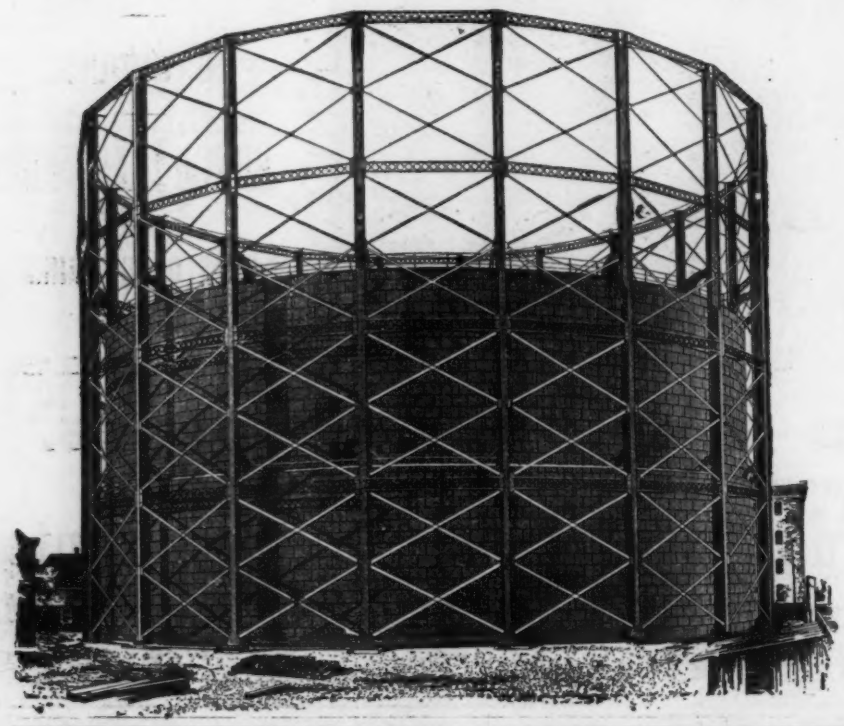

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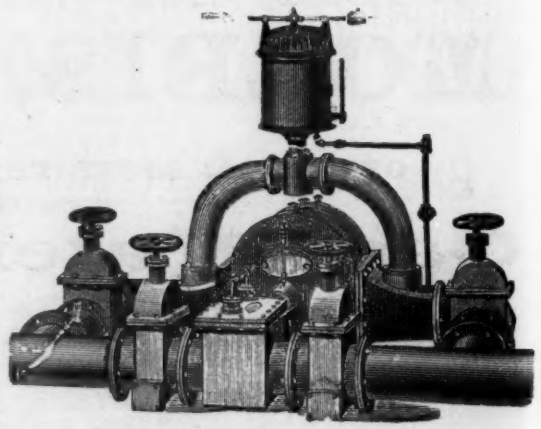

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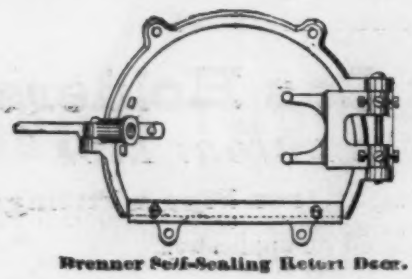

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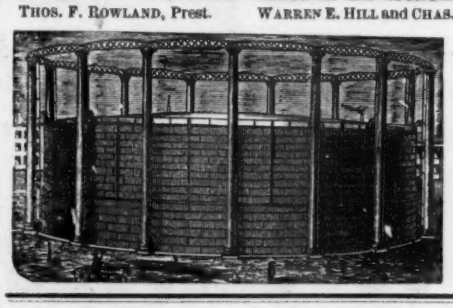

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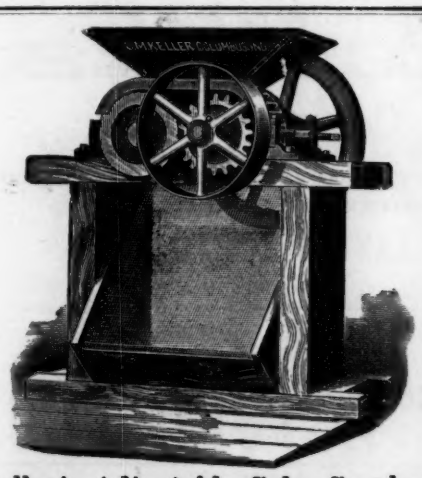

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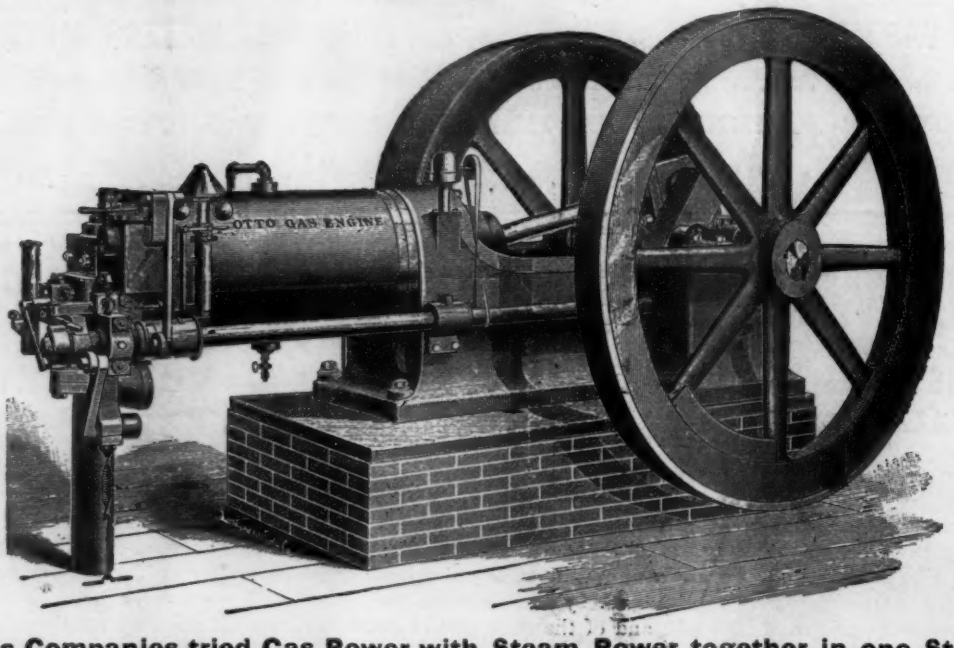

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